2005 Hurricane Katrina Wildland Fire Risk Assessment

photo provided by Larry Moore, Desoto Ranger District, NF's in MS

September 5, 2005

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Executive Summary

The central Gulf Coast has been impacted by two tropical storms (TS Arlene and Cindy) and two hurricanes (Hurricane Dennis and Katrina) during 2005. This report will focus on Hurricane Katrina, since this hurricane caused the most damage. The intent of this assessment is to evaluate increased wildland fire risk to the hurricane damaged areas. Hurricanes significantly impact forested lands at several scales and often set the stage for more intense fires. A description of the hurricanes are included. After the 2004 Hurricane assessment it was estimated about 55 million acres were affected after four hurricanes. Hurricane Katrina affected approxiamately 60 million acres.

Determination of post hurricane fuel conditions was done on a very general scale due to the time constraints. Maps displaying the wind velocity, rainfall patterns, and tornado activity were developed and used to generate maps of damage areas. Four damage level catagories were determined (scattered light, light, moderate, and severe). This was validated based on visual observation in the effected areas.

The total land affected by the Hurricane Katrina is 60,840,000 acres. Of this, 32, 548,000 acres will need additional preparedness, fire prevention and fuel reduction work to mitigate the damage caused by the hurricane. Ninety percent of the damage is located on state or private land, with the vast majority of this being on private land. Theses acre numbers do include non-forested land.

This additional workload is well beyond the normal fire budget of the state and federal agencies.

Local fire managers were contacted to verify damage and general assumptions used in this assessment, plus provide tactical proposals to for mitigating fuels build up situation. The strategy includes prevention, preparedness (initial attack), support to local fire districts and fuels treatments.

Short range forecast for the affected are indicate below normal rainfall for the next 14 days. Normal rainfall conditions are expected over the next several months. However, September and October are the two months with the lowest annual rainfall for the area. Unless, significant mitigation steps are taken immediately, one can expect wildland fires to pose very real hazard to the area. This will obviously be a long term issue as well.

Recommendations

General recommendations are made for prevention, preparedness resource needs above normal staffing and fuels treatment are proposed at a total cost of over 223 million dollars. Immediate and long term fire prevention activities should take place. Increases in the number and capabilities of initial attack resources is required. Also, extensive fuel reduction work will be needed. This will require both mechanical and prescribe burning activities. This will require collaboration with local, state and federal agencies.

Due to extraordinary costs and number of acres damaged, additional assessments will be needed. These can be done at the local level based on actually mapping (which was not available at the time of this analysis) and tiered to state level assessments. The analysis at the state level will be needed in order to prioritize the work to be done and the allocation of funding for suppression resources.

Introduction

The demand for long-range fire assessments has been increasing during the last decade and increased needs for better information to support fire management decision-making will continue to grow (Mutch 1998). Long-range assessments ranging in magnitude have been periodically completed since 1987 for various parts of the United States (Zimmerman et al. 2000). Though the specific objectives vary on each project, these assessments are generally look at short and long term wildland fire issues. Assessments are generally large in scale compared to a specific single wildfire event. A 2004 Hurricane Assessment was also completed in 2004 to evaluate the impacts of the four major hurricanes which hit Florida.

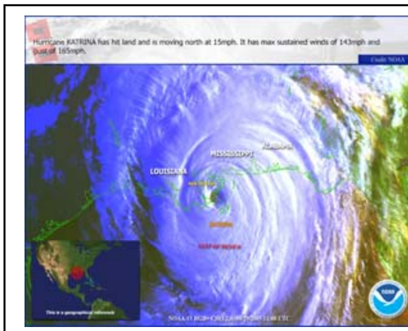
Significant Events

Hurricane Dennis

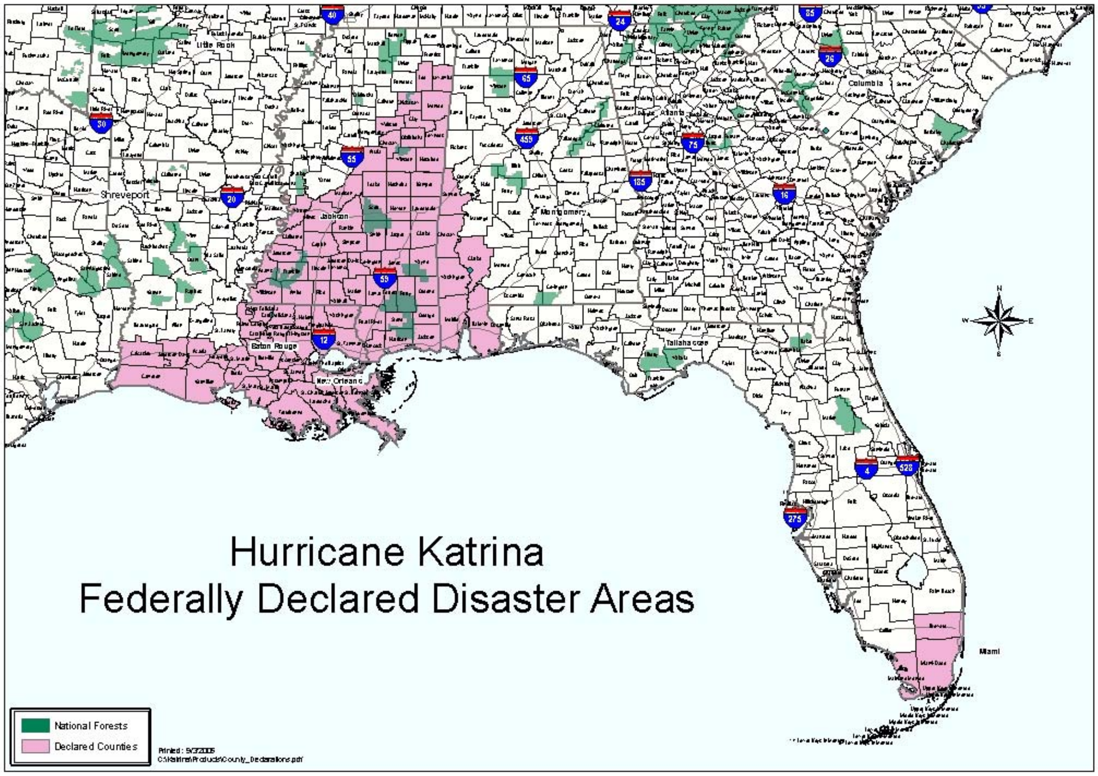
Dennis made landfall on the extreme western tip of the Florida Panhandle around 300 pm EDT on Sunday, July 10. At landfall, his winds were reported at 121 mph, a strong Category 3 Hurricane. Dennis' winds quickly decreased and his center entered extreme southern Alabama around 900 pm with maximum winds quickly dropping from 104 mph to 58 mph. Dennis continued to move northwest through sunrise on Monday, July 11 and the center of his circulation was situated along the Mississippi/Alabama border near Columbus, MS at 500 am EDT. However, his winds were down to 35 mph, and the outer rain bands were pelting western Georgia.

Hurricane Katrina

Katrina made first landfall at 1900 eastern time on August 25 between Hallandale Beach and North Miami Beach with 80 mph winds. Katrina then moved West across the southern tip of Florida, into the Gulf of Mexico and began to strengthen. Katrina continued to gain strength over the next four days and made a second landfall on August 29 near Grand Isle, Louisiana with winds speeds of 144 mph. She then clipped the southeastern toe of Louisiana, and made a third landfall near Bay Saint Louis, Mississippi. Katrina caused massive damage along her path. Levy breaks in New Orleans attributed to Katrina flooding 80% of the city.



Declaration of Federal Disaster Areas



The highlighted counties above were all declared Federal Disaster Areas.

The objectives for the assessment by the team were to:

Generalize the effects of Hurricane Katrina across the southern area.

Identify potential risk associated with the added buildup of fuels.

Identify mitigation measures and estimate costs of implementing those measures.

The team assigned included:

Clint Cross - USDA Forest Service, Atlanta, GA,
Tracey Adkins - USDA Forest Service, Atlanta, GA

The intent of this paper is to provide:

- A brief review of current conditions associated with the impact of Hurricane Katrina on the coastal plains of the southeastern United States as they relate to fire risk.
- An estimate of the potential damage to forested stands and how that relates to a change in fuels and fire behavior.
- A weather outlook for the remainder of the 2005 fire season.
- A listing of potential fire risk mitigation measures and estimated costs associated with mitigation measures.
- Suggestions for follow-up actions.

Current Situation

Tropical Storm Arlene

Arlene developed as a weak low pressure area off the coast of Honduras on Jun 8 and rapidly became Tropical Depression One by June 9. TD 1 was officially upgraded to Arlene at 800 am on Jun 9. She was located at 19.1 N, 84.0 W or 190 miles south southeast of the western tip of Cuba. At this juncture, she was forecast to come into the vicinity of Mobile Bay around 1 AM Sunday June 12.

By 1100 am Fri Jun 10, Arlene was packing winds of 55 mph and was located at 24.0 N, 84.9W. Arlene is now forecast to move into extreme southern Mississippi, near Pascagoula. Maximum winds are expected to increase to 69 mph (just shy of hurricane strength)shortly before landfall during the evening of Saturday June 11. Arlene indeed did see her winds increase to 69 mph. This occurred around 800 pm EDT June 10.

On June 11, Arlene's winds continued at 69 mph and this was as strong as she was to become during her lifecycle. Arlene made landfall just east of Mobile Bay (along the Alabama-Florida border) around 200 pm CDT on Saturday June 11 with maximum winds of 58 mph. Arlene then tracked across Western Alabama, Central Tennessee, and crossed the Ohio river near Evansville, IN before continuing into northeast Indiana and New England.

Arlene's damage was primarily associated with flooding. At Gulf Islands National Seashore, Arlene washed out about 60% of the Fort Pickens Road and undermined the shoulder of the Opal Beach Road. About 4000 customers lost power in Escambia County, Florida and a possible tornado was reported near Navarre in Santa Rosa County, Florida. Funnel clouds were reported near Montgomery, Alabama. Rainfall associated with Arlene was widespread from western Kentucky southward across middle and Western Tennessee, eastern Mississippi, and most of Alabama. A small area of 5 to 8 inches fell in Northeast Mississippi. Arlene also gave widespread rainfall to Georgia and Florida.

Tropical Storm Cindy

Tropical Depression Three developed near 18.4 N and 87.1 W on Sunday July 03, 2005. This location is just off the southern tip of the Yucatan Peninsula and just offshore from the Mexico-Belize Border in the northwest Caribbean. Initial motion was to the northwest at 9 mph. As the depression moved across the Yucatan Peninsula, it remained just under Tropical Storm Strength. It was still a tropical depression when it emerged into the Gulf of Mexico along the Northern Yucatan Peninsula around noon EDT on July 04, 2005. Tropical Depression Three officially became Tropical Storm Cindy at 400 am CDT on Tuesday July 05, 2005.

When Cindy acquired a name, she was located at 25.6 N, and 90.4 W, or about 255 miles south-southwest of the mouth of the Mississippi River. Tropical Storm warnings were issued for the area stretching from Intracoastal City, LA to Pascagoula, MS including the city of New Orleans and Lake Pontchartrain. She was moving north-northwest at 14 mph with maximum winds of 40 mph. By 700 am July 05, 2005, Cindy's winds had increased to 45 mph, and then increased to 50 mph by 1000 am. By 700 CDT on July 5, Cindy's winds had increased to near 70 mph with tropical storm force winds extending out 105 miles from the center.

By 1000 pm CDT July 05, Cindy was located at 29.0 N and 90.1 W or about 20 miles south-southwest of Grand Isle, LA. Cindy made landfall very close to Grand Isle, LA between 1100 pm CDT July 05 and 0100 AM CDT July 06. Maximum winds at landfall were 70 mph. By 200 am CDT on July 06, the maximum winds were down to 65 mph, and by 400 am they were down to 60 mph. At 400 am (July 06, 2005) Cindy was located near 30.1 N and 89.7 W. and moving northeast at 14 mph. This track will take her across extreme southern Mississippi, to just east of Birmingham, AL, to near Rome, GA, then near Asheville, NC and then to near Washington DC.

Cindy was responsible for street flooding and for power outages in southern portions of MS and AL upon landfall. Some structural damage was also reported on Grand Isle, LA. 24-hour rainfall totals of 4 to 8 inches were recorded along the Gulf Coast.

The remnants of Cindy moved to near Rome, GA by 700 am July 7. She deposited 3 to 6 inches of rain in the Atlanta metro area, resulting in street flooding and some evacuation of homes along Peachtree Creek. There were six confirmed tornadoes on the southern fringe of metro Atlanta with Cindy's remnants. Damage from these tornadoes ran to $75 million with a significant portion of that occurring to the Atlanta Motor Speedway, where damage was in excess of $25 million.

During the day on July 7, Cindy's remnants continued northeast along the eastern slopes of the Appalachian Mountains, depositing two to five inches of rain. Early on July 8, the remnants of Cindy were located in northern Delaware, with extensive rains falling over central and eastern Pennsylvania, Delaware, Maryland, New Jersey, Connecticut, southern New York and extreme northern Virginia.

Hurricane Dennis

Tropical Depression Four developed around 1100 pm EDT on Monday, July 04, 2005 at 12.5 N 63.1 W or about 100 miles west-northwest of Grenada. Initial motion was to the west-northwest at 17 mph with maximum winds of 30 mph. Dennis was officially named at 1100 am EDT on Tuesday July 05. It was located at 13.3 N 66.6 W with maximum winds of 40 mph or about 355 miles south of San Juan, PR. Tropical Storm force winds extended outward 60 miles from the center.

Dennis continued to gain strength during the day (Tuesday) July 05. By 1100 pm EDT, maximum winds were near 50 mph. Strengthening was forecast, and Dennis will likely become a hurricane on July 06. Dennis is expected to produce rainfall totals ranging from four to six inches on Hispaniola with maximum totals approaching ten inches in mountainous terrain.

By 500 am EDT Wed July 06, Dennis' winds had increased to 65 mph and he was located at 15.1 N and 70.3 W with tropical storm force winds extending outward 85 miles from the center. Dennis was moving west-northwest at 16 mph and is expected to pass near Jamaica early on Thursday July 07. Dennis is expected to pass just north of Jamaica, then across the western tip of Cuba, and come into the Gulf of Mexico. Dennis will likely gain strength in the Gulf of Mexico and is forecast to come into the Florida Panhandle near Pensacola around 200 am Monday July 13.

At 600 pm on July 6, 2005 Dennis was officially upgraded to Hurricane status with maximum winds at 80 mph with hurricane force winds extending out 25 miles from the center and tropical storm force winds extending out 105 miles from the center. At this juncture, Dennis was located at 16.1 N and 72.5 W or about 315 miles east-southeast of Kingston, Jamaica. Dennis was forecast to be very near to Jamaica by Thursday July 7. Dennis' winds increased to 85 mph by 11 pm EDT July 6.

On Thursday, July 7, Dennis's winds increased to 90 mph by 500 AM EDT, and then to 105 mph by 800 am, a dangerous category two hurricane. At 800 am EDT Dennis was located at 17.5 N an d74.9 west or about 130 miles east-southeast of Kingston, Jamaica. Dennis' forward motion also slowed to west-northwest at 13 mph. Dennis' official forecast track takes him across the eastern portion of Jamaica, then across the western tip of Cuba, into the Gulf of Mexico. Landfall is projected to occur near Mobile Bay between 200 am Sunday and 200 am Monday. Dennis began to develop a well defined eye on July 7. At 0115Z July 8, the eye of Dennis passed over the extreme western tip of the "base" of Cuba.

On Friday, July 8 at 500 am, Dennis was located at 20.7 N and 79.1 W, or about 275 miles southwest of Havana, Cuba. Dennis' winds had reached 135 mph at 500 am making it a dangerous category four hurricane. It was moving northwest at 16 mph and its central pressure was down to 950 mb or 28.05 inches of mercury. Dennis is still expected to cross the western portion of Cuba on July 8, and emerge in the Gulf of Mexico just west of the Florida Keys. Landfall is still projected for the Alabama/Florida border area shortly before 200 am Monday July 11.

At 1100 am July 8, 2005 Hurricane Dennis' winds had increased to 150 mph, just 5 mph shy of a category five hurricane. Dennis was located at 21.4 N and 79.9 W. This was to be Dennis' all time peak wind speed. Dennis crossed the island of Cuba and emerged in the southeastern Gulf of Mexico as a Category 2 hurricane with maximum winds at 98 mph at 300 am EDT on July 9.

During the day on July 9, Dennis' gradually gained back his strength as he plowed northwest in the Gulf of Mexico. His outer rain bands deluged the west coast of Florida from Ft. Meyers to Tampa. In fact, the entire Sunshine State was not so sunny and even northern sections of the Florida Peninsula stretching from Tampa to Tallahassee received 1.5 to 3.0 inches of rain on July 9. (On July 8, the area stretching from Tampa to Miami and westward to Ft. Meyers received 3.0 to 5.0 inches so rain.) Dennis returned to a Category 3 hurricane around 700 pm on July 9. Dennis recovered to 144 mph, a strong Category 4 storm at 300 am on July 10. Dennis maintained Category 4 status until just a few miles away from the Coast. By 100 pm on July 10, Dennis had decreased to 132 mph.

Dennis made landfall on the extreme western tip of the Florida Panhandle around 300 pm EDT on Sunday, July 10. At landfall, his winds were reported at 121 mph, a strong Category 3 Hurricane. Dennis' winds quickly decreased and his center entered extreme southern Alabama around 900 pm with maximum winds quickly dropping from 104 mph to 58 mph. Dennis continued to move northwest through sunrise on Monday, July 11 and the center of his circulation was situated along the Mississippi/Alabama border near Columbus, MS at 500 am EDT. However, his winds were down to 35 mph, and the outer rain bands were pelting western Georgia.

Dennis continued to track northwest to near Tupelo during the afternoon of July 11, and by the morning of July 12, his remnants were situated in southern Illinois, just south of Springfield. Dennis' rains were pelting areas stretching from southern Michigan and extreme southeast Wisconsin southward over most of Missouri and eastward into Indiana.

Hurricane Katrina

Tropical Depression Twelve developed on Tuesday August 23 at 23.2 N and 75.5 W or about 175 miles southeast of Nassau, Bahamas. Maximum winds were 35 mph and strengthening was expected to occur during the day. By 500 am EDT on Wed August 24, it was still a tropical depression, located at 24.0 N and 76.4 W, or 95 miles southeast of Nassau. The depression was moving to the northwest at 7 mph and was still expected to strengthen into a tropical storm with winds to 69 mph just prior to a landfall near Fort Lauderdale on Aug 26 shortly after 200 am and then restrengthen in the Gulf of Mexico to 75 mph. Tropical Depression Twelve officially became Tropical Storm Katrina at 200 PM EDT Wed, Aug. 24 with winds to 45 mph, eventually gaining strength to 50 mph at 1100 pm.

On Thursday, August 25, Katrina was still at 50 mph at 800 am. Tropical storm force winds extended out 70 miles from the center. She is now expected to cut across the southern third of Florida, making an initial landfall between Ft. Lauderdale and Boca Raton between 200 am and 500 am on Friday, August 26. She is expected to emerge on Florida's west coast between Naples and Ft. Meyers around 400 pm Aug 26. From that juncture, she is expected to regain strength to 81 mph before making a second landfall near Apalachicola Bay around 200 am Monday Aug. 29.

Katrina continued to gain strength as she moved west during the day. By 100 pm EDT she was up to 65 mph and by 300 pm she was up to 70 mph. At 500 pm she increased to 75 mph, making her a Category One hurricane. At that juncture she was located at 26.1 N and 79.9 W or about 15 miles east-northeast of Fort Lauderdale. Katrina's eye made landfall at 700 pm Thursday August 25 between Hallandale Beach and North Miami Beach with 80 mph winds. Port Everglades reported gusts to 92 mph shortly before 700 pm.

By 900 pm August 25, Katrina began moving just south of due west as she maintained maximum winds of 80 mph. Hurricane winds extended outward 15 miles and tropical storm force winds outward 80 miles. By 1100 pm, she was actually moving southwest. She continued moving southwest through the night and resumed a westward motion at 500 am EDT Friday August 26. Even though Katrina dropped below hurricane strength briefly during the overnight hours, she quickly regained hurricane strength upon moving offshore. She moved off the southwest Florida coast near Shark Point, just north of the mouth of Whitewater Bay between 100 and 200 am Aug 26.

By 700 am Aug 26 Katrina was located at 25.3 N and 81.8 W or about 50 miles north of Key West. Katrina had winds to 75 mph which extended out 25 miles from the center, along with tropical storm force winds to 85 miles from the center.

Katrina continued to gain strength as she tracked across the Gulf of Mexico Aug 26-28. Winds quickly increased to 100 mph by 500 pm Aug 26, to 115 mph at 500 am Aug 27. She held at this strength for most of the day, but by 100 AM CDT Sunday Aug 28, her winds took a dramatic jump to 145 mph, then to 160 mph at 700 AM and to 175 mph at 1000 AM. This was to be her peak speed, with hurricane force winds extending outward 105 miles from the center. Tropical storm force winds extended out 205 miles from the center. She decreased to 165 mph between 100 pm and 400 pm then to 155 mph by 200 AM Monday August 29. Katrina made landfall as a strong category four hurricane with maximum winds of 144 mph just after 700 am on Monday August 29, 2005. She came ashore very close (or perhaps a few miles slightly east of) Grand Isle, Louisiana. As she clipped the southeastern "toe" of Louisiana, she made a second landfall near Bay Saint Louis, Mississippi.

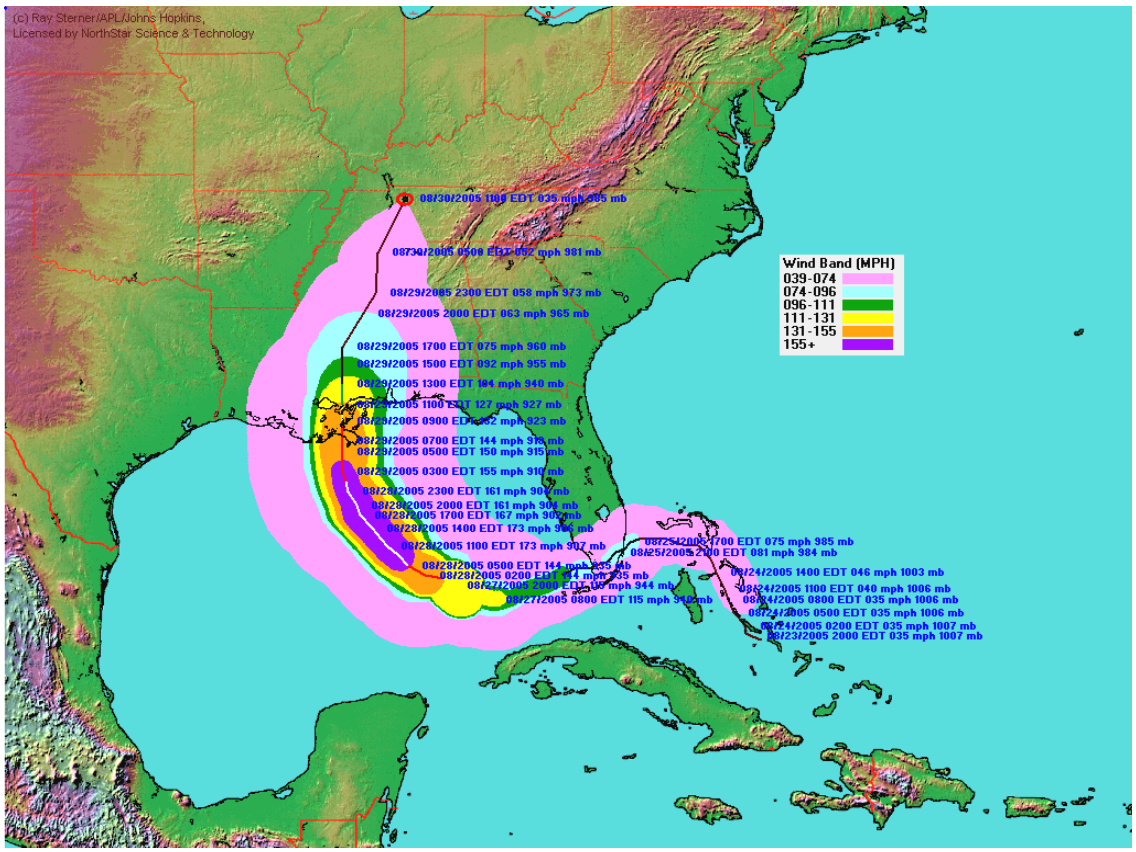
Catastrophic damage occurred all along the Gulf Coast region from Morgan City eastward to Mobile. Nearly every building sustained roof damage, many homes were completely demolished. Even the metro-dome in New Orleans, which was used to shelter 25,000 people, had the roof torn off so that the rain poured inside upon the refugees gathered there. Water rose so quickly in homes that people were trapped inside their attics before they could access the roof. Mandatory evacuation orders were given. As of this writing (Aug 31) over 100 deaths have been attributed to Katrina, many of them in Harrison County, Mississippi. The entire Grand Casino was lifted off and moved several blocks from its "anchored" location. The storm surge with this storm exceeded 20 feet, a disastrous amount of water for a city such as New Orleans that sits 25 feet below sea level. At least two levees in New Orleans broke and it is estimated that it will take at least a month to pump the water out of the city. Officials estimate that 80% of New Orleans is under water as a result of Katrina. Dead bodies floating in the water are being ignored in an effort to rescue those that are living on their rooftops.

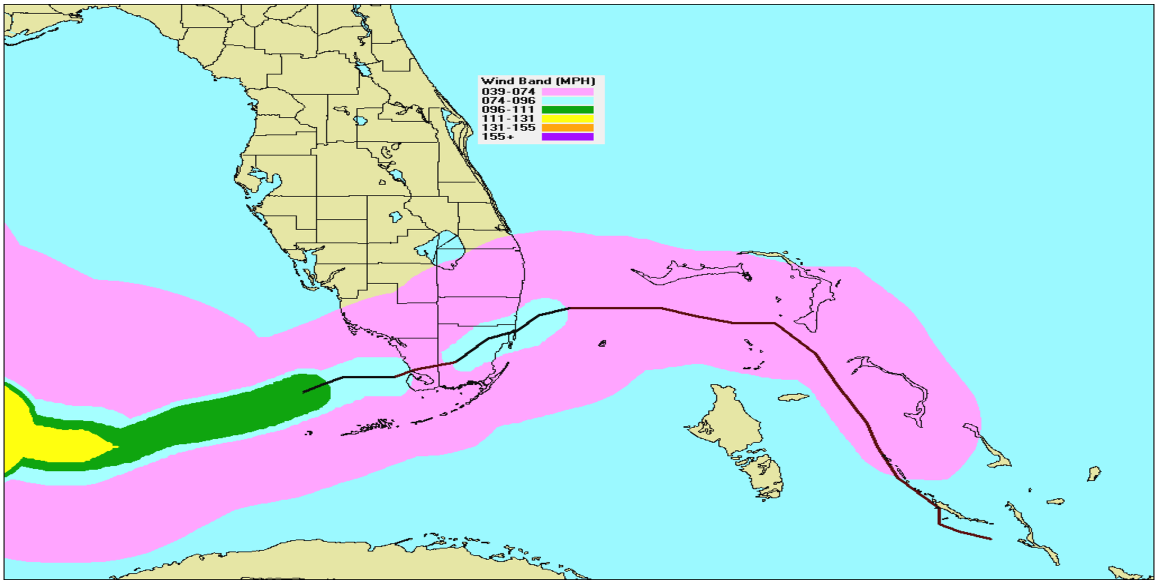
Katrina's track after landfall took her across eastern Mississippi and central Tennessee just east of Clarksville, TN. She then moved toward the Covington, KY and Cleveland, Ohio (on Aug 31) areas. She maintained at least tropical storm force winds well into southern Tennessee and as late as 400 PM CDT August 29. She was downgraded to a tropical storm at 700 pm Monday August 29, and then to a depression at 1000 am Tuesday August 30. By the time she was categorized as a depression, she was located about 25 miles south of Clarksville, TN.

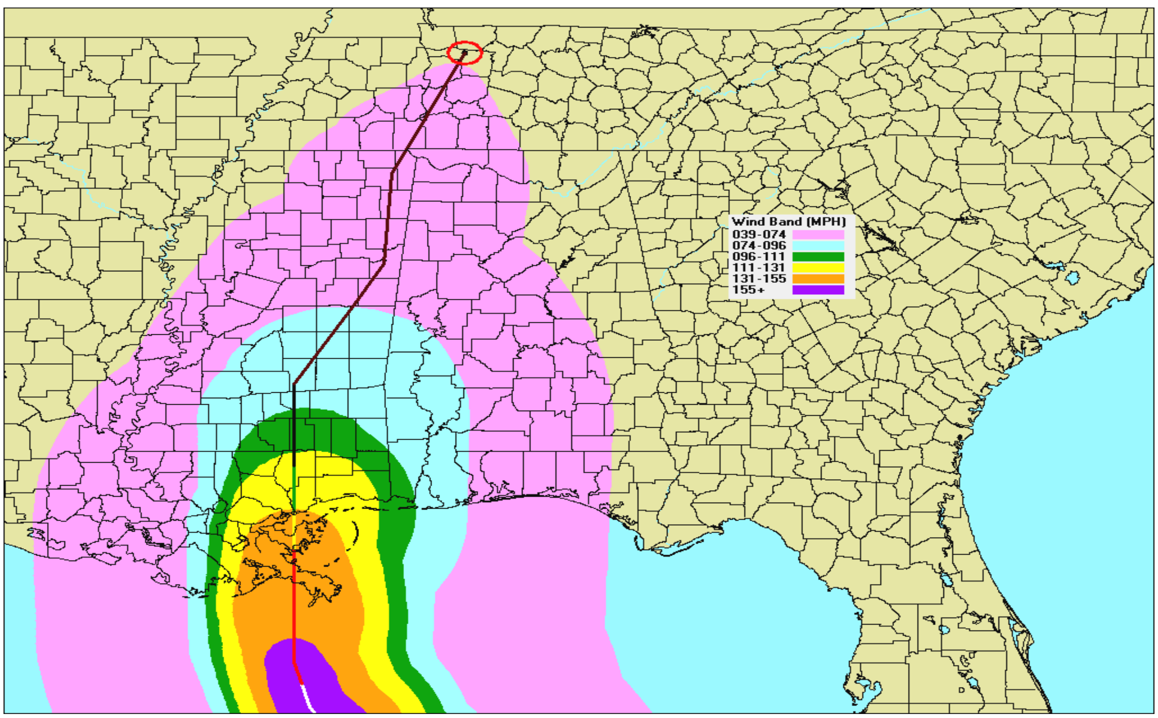
Wind Velocity Projections

Hurricane Katrina

The following charts illustrate the movement of Hurricane Katrina as it made landfall across the southern tip of Florida, moved into the Gulf of Mexico, and made another landfall in Louisiana. Wind speeds are depicted in the graph. The track of the eye of the hurricane and wind speeds are depicted on all charts.







These wind speed charts, along with rainfall patterns were used to evaluate the impact of the hurricane on fuel build up. This is a very rudimentary analyses used to identify areas that will require on site evaluation to determine actual fuel loadings and mitigation measures. The purpose here is to make an estimate of the number of acres impacted and to what degree the area has been damaged. The methodology for this analysis has been used on several assessments such as the 2004 Hurricane Assessment.

Normal Fuels and Fire Behavior

Coastal Plains

Vegetation of the Coastal Plains dominates the southern landscape in terms of sheer size. The central Florida peninsula and panhandle and the coastal edges of Mississippi, Alabama, Georgia and the Carolinas support forests of Slash, Longleaf and Loblolly pine growing on well-drained sandy-soils. Much of the true flatwoods grow on poorly drained soils, however. The understory consists of fast growing communities of wire grass, palmetto, gallberry and titi (pronounced "tie-tie"). Western coastal plain states also feature mixed communities of pine and oak-hickory with thickets of scrub oak. Palmetto, gallberry and titi dominate the southeastern coastal areas. Pocossins dominate along the Carolina coasts, with interspersed islands of upland pine.

Palmetto, gallberry, pocossin and particularly titi are volatile species and will burn intensely when green even under "normal" burning conditions. Palmetto-Gallberry roughs are described by their age, as in a 1 or 3 year rough. Bulk density of the rough increases with age. The Florida fires of 1998 burned through roughs exceeding 20 years in age. Needle-drape from the pine overstory will contribute to fire intensities, especially as the age of the rough increases. Titi grows in wet lowlands and along coastal waters, often encroaching upwards upon pine uplands. Prescribed under burning of titi understory frequently results in extensive scorch of the overstory pines.

Palmetto-gallberry is best modeled by Fuel Model 7 in younger roughs, transitioning to Fuel Model 4 as the rough exceeds an age of 5 to 7 years. Fire behavior increases dramatically in this model as live fuel moistures (LFM) drop below 120 to 130 percent and becomes extreme when LFM drops below 100% with relative humidity less than 40%. The model responds quickly to changes in fine dead fuel moisture and will burn well even at high dead fuel moistures, given the volatility of the live foliage. Spotting is a common problem in this fuel type.

Southern rough is characterized by a frequent, low to moderate intensity fire regime. Prescribed burning is typically conducted on a 3-year rotation to maintain the sites. The wet nature of the site and the lack of available large fuel results in a hot-burning fire of short duration. Little or no mop-up is usually required. Burning conducted during dormancy will maintain a low density rough. Burning during the growth phase of palmetto-gallberry will result in site conversion to an understory of grass (FBPS Fuel Model 2).

Cypress swamps and other wet, hardwood lowlands punctuate the coastal plain, and are interspersed with loblolly and slash pine forests. Okefenokee Swamp along the Georgia-Florida border are one example. Swamps act as a natural barrier fuel under normal burning conditions. Low water tables brought on by drought conditions allow fire to burn freely in swamp ecosystems. Models representing this fuel complex vary. Fuel Model 8 best represents the dry swamp

bottoms of compressed tree litter. Fuel Models 6 or 9 may represent hardwood shrubs and other species present in the understory. The fire ecology of cypress swamps is typified by a stand replacement regime. Potential for severe, high intensity fire exists under extreme burning conditions. Smoldering ground fire can consume massive amounts of fuel, exposing root structures, weakening, toppling or killing overstory trees.

Dense stands of sand pine are located in central Florida, in and around Ocala National Forest. Sand pine stands are characterized by a stand replacing fire regime and exhibit the "all or nothing" burning conditions typical of old growth lodgepole or subalpine fir forests of the Intermountain West. Mature pine flatwoods will not usually "crown" in the western sense of a continuous, running crown fire. Torching of individual or groups of trees does occur under hot and dry conditions described in the palmetto rough above.

Wildfire size and intensity varies in coastal rough depending on the age of the fuel complex. Wildfire on sites maintained by prescribed fire are usually controlled with minimal resources at A and B size classes. Sites not maintained by prescribed fire have historically experienced C and D class fires with greater intensities, and require a greater number of resources to control.

Cypress Glade and Savannah

Southern Florida is a complex arrangement of sawgrass savannas, wet prairies, cypress domes and hardwood hammocks. Slash pine flatwoods with palmetto rough understory are common in the northern range of the area. Elevation, substrate and water levels play a major role in the vegetative diversity of the area. A change of only a few inches in elevation will cause a significant difference in vegetative composition.

Wet prairies and sawgrass savannas are best modeled using FBPS Fuel Model 3. Fuel Model 9 best represents bayheads, hardwood hammocks and cypress domes. It should also be noted that these areas also present the possibility of smoldering peat fires during drier periods. Pine flatwoods are represented by Fuel Model 2, with Fuel Model 7 best modeling roughs 3 years or less in age. Fuel Model 4 should be considered for older roughs.

Savannas, prairies and palmetto rough present the potential for moderately intense fire. Live fuel moistures and wind are major contributors to fire intensity in these models. Spotting is most common in palmetto rough.

Most of the cypress glade and savanna area is characterized by a frequent low to moderate intensity fire regime. Sawgrass savannas have been known to burn multiple times in a single season. Cypress domes and hammocks tend towards a longer interval, stand replacement regime. Most prescribed burning in the physiographic area takes place after the end of the October rainy season.

Water-use patterns, which could restrict flow through swamp and wet prairie ecosystems, which will magnify drought effects.

Piedmont

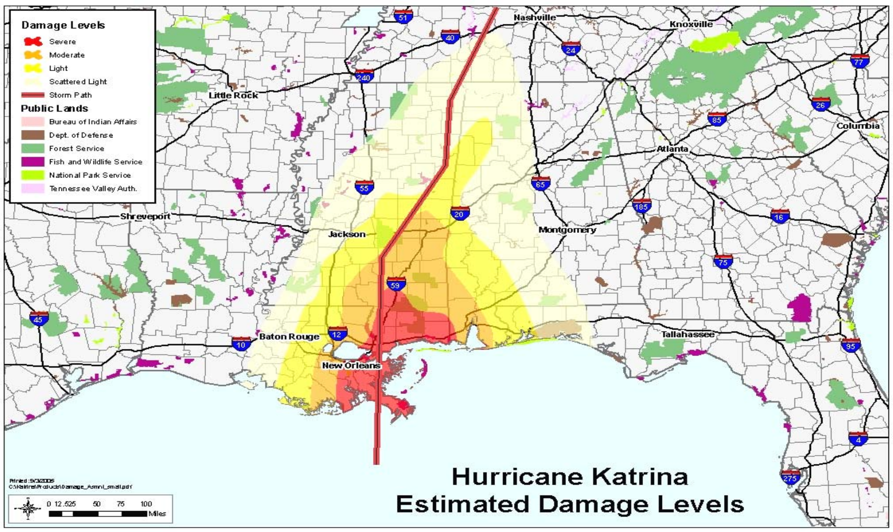
The Piedmont, translated literally as “Foot of the Hills”, occupies the mid-elevation band on the southern landscape. The portion of the Piedmont east of the Mississippi was intensively managed in the past and experienced a massive loss of topsoil from poor agricultural practices. It is estimated that less than 3% of the original landscape exists. West of the Mississippi River, the Piedmont retained much of its native forest, and having avoided the loss of topsoil, has retained much of its original productivity. For the most part, the Piedmont is a transition zone between the pine/shrub communities of the coast and the hardwood communities of the Appalachians and the Ouachita Highlands. Kuchler describes the area as a Loblolly-Shortleaf ecosystem, interspersed with oak-pine mixed ecosystems. Fire maintains pure stands of pine, while in the absence of fire hardwoods and hardwood shrubs will proliferate. Cultural fire maintained much of the original Piedmont forest. Agricultural lands and rural and urban communities have fragmented much of the existing landscape.

Piedmont forests are best modeled using Fuel Model 2, 8 or 9, depending on the openness of the stand, time of year and species composition. Stands dominated by pine will tend towards Fuel Model 2 or 9, and will transition from 2 to 9 in the absence of fire. Stands dominated by hardwoods are best modeled using Fuel Model 8 in the spring and 9 in the fall after leaf drop. Spotting in this fuel complex is usually a function of leaves being carried by the wind. As a result, spotting is a greater problem in the fall than the spring in a normal year. The mesic nature of the Piedmont and the southeast in general precludes larger fuels from having any significant contribution to fire intensities or spread.

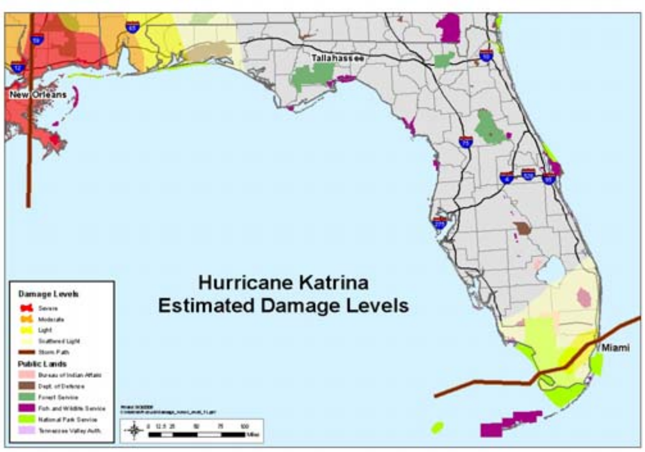
Wildfires are typically small and easily controlled. Large fires are infrequent and ignitions relatively few compared to the coastal environment. Most fires are human-caused. Fire intensity levels are usually low, with low rates of spread except in the presence of a significant wind.

Existing fuel conditions and potential fire behavior

Determination of existing fuel conditions was done on a very general scale due to the time constraints. Damage levels were determined based on windspeed maps and rainfall patterns following landfall of Hurricane Katrina. These windspeed maps and rainfall patterns were compared with visual observations on the ground, looking at current damage. Observation included comparing these same windspeed/rainfall patterns with damage found on past hurricanes. Based on these past and current observations, four damage catagories were determined. The adjective ratings for these four catagories are: scattered light, light, moderate and severe. Damage level maps illustrating these catagories are located in the Appendix A.



Scattered light damage level is characterized by tropical storm forced winds (39 to 74 mph) and moderately heavy rain. The light damage level is described as low Category One Hurricane winds (generally less than 85 mph) and slightly heavier rains found in the scattered light damage level. The moderate damage level is determined by winds above 85 mph up to 111 mph (includes a high Category One and all wind speeds of a Category 2). Heavy rains are found in these areas. The severe damage area is characterized by Category 4 and 5 hurricane winds and very large rainfall amounts.



Fire Behavior Prediction System (FBPS) fuel model maps derived from the Southern Area Fire Risk Assessment were evaluated to determine which fuel models were present within each damage category. Based on past and current observations it can be determined the approxiamate amount of damage by fuel model, within each damage category.

The **scattered light damage level** is the most predominate across the effected area. Fuel loading in the damage level is the least impacted. Damage can be described as small limbs on the ground, the occasional tree blown over, and generally the same impact that would be associated with thunderstorm activity. No significant change to the fuel loading present prior to the hurricane. Fire behavior and potential will be the same as pre - hurricane levels. Fuel bed depth, particularly in hardwood and pine stands will increase slightly. The canopy is still in place.

A **light damage level** can be generally characterized by the same loading for each fuel modeling as in the FBPS. However, there will likely be some additional fuel loading in the 1hr, 10hr, and 100hr fuel classes. Damage could be described as mainly small to large size tree limbs, downed trees, and a increase in litter on the ground. Fuel bed depth will increase moderately in timber stands. The canopy is slightly broken. Fire behavior and potential will increase in the short term in these areas. Expected slightly higher flame lengths and fire line intensities in the next few weeks as smaller diameter fuel classes dry out.

The **moderate damage level** has significant changes to the fuel models represented. In areas where a timber model is present (fuel model 8 and fuel model 9) expect more of a fuel model 11 (light slash) or fuel model 12 (moderate slash) to be represented after the storm. This area will see a wide diversity of fire behavior characteristics. Damage can be described as numerous small, medium and large diameter limbs are on the ground. A significant amount of trees are on the ground, tops broken out of trees. The canopy of the forest is fragmented. The fuel bed depth for each fuel model has increased dramatically. Fuels are arranged more horizontally than vertically. The more open canopy will allow for an increase in solar radiation to reach the surface fuels as well as more exposure to winds. These effects will tend to exacerbate fire behavior beyond what would be accounted for by just adding more fuel. The resistance to control will also increase. The heavy fuel loading will make suppression more difficult. Control lines will need to be wider to have the same effect prior to the storms. Line construction rates will be slower and in some areas direct control lines will not be possible due to heavy loadings of larger material. Multiple kinds and types of resources will be needed for fire suppression. Aerial resources, combined with dozers and engines will be needed. Commitment of resources will be longer for each fire start due to longer mop up times. This will be due to the increase heavy fuels on the ground.

The area of wide spread destruction of the forest stand itself is described as the **severe damage level**. In this area, around 25% to 40% of timber have been laid on the ground by the storms or all the tops have been broken. In areas where the pre-hurricane fuel model present was a FBPS fuel model 8 or 9, expect a fuel model 12 or 13. There is very little live fuel left in the fuel bed in the short term. A tremendous change in the fuel bed structure has taken place. 1hr, 10hr, 100hr, and 1000hr fuel loadings have all increased dramatically, especially the 1000hr. The forest could be considered "jack-strawed." Prior to the storms, no fuel models 11, 12, and 13 existed in Alabama, Mississippi or Louisiana. Now these models are present in a large scale. The completely open canopy will drastically increase the amount of solar radiation to the fuel bed. This will cause dead fuels to rapidly dry out. This will also cause an increase in the mid flame wind speeds. The increase in available fuel will also increase the source for spotting and therefore increase the spotting potential. Smaller dozers (450's) will be ineffective due to the increase in large diameters fuels on the ground. Large dozers (650's) combined with engines and aerial resources will be needed to suppress fires.

Another critical issue that has impacted mainly the area closest to the coast is salt damage to vegetation. The picture to the right is salt damage from Hurricane Katrina. Notice how both the understory and overstory appear scorched. However, the dead needles remain on the tree. This could cause potential problems in the near future. It is likely these dead needles will drop to the ground and provide enough fine fuel to carry a fire. In areas where the needles remain on the trees, then torching or crowning could occur if there is fuel build up below the canopies of the trees. Areas which have a heavy combination of brush will most likely prove the most volatile. These fuel types will have a heavy dead component to the understory and allow fire to move rapidly into the crowns. Prescribe burning in these areas will prove hazardous do to the volatile nature of the fuels. Prescribe burning will also likely produce higher concentrations of smoke and large particulate matter due to the above normal amount of dead fuel.

This salt damage is estimated to occur 10 to 15 miles inland. Generally, south of I-10 to the coast. However, there are salt killed areas north of I-10 on the extreme west side of Mississippi.

Damage estimates (in acres) by Major Landownership

Damage Levels	*BIA lands affected*
Severe	-
Moderate	656
Light	169,943
Scattered Light	685
Total BIA affected	***171,284***

Damage Levels	*FWS lands affected*
Severe	137,902
Moderate	44,877
Light	199,048
Scattered Light	160,641
Total FWS affected	***542,468***

Damage Levels	*DOD lands affected*
Severe	7,242
Moderate	19,899
Light	54,415
Scattered Light	530,251
Total DOD affected	***611,807***

Damage Levels	*NPS lands affected*
Severe	28,024
Moderate	-
Light	1,712,096
Scattered Light	10,238
Total NPS affected	***1,750,358***

Damage Levels	*FS lands affected*
Severe	425,768
Moderate	480,136
Light	291,357
Scattered Light	1,682,056
Total FS affected	***2,879,317***

Damage Levels	*TVA lands affected*
Severe	-
Moderate	-
Light	1,032
Scattered Light	99,303
Total TVA affected	***100,335***

Damage Levels	*State/Private affected*
Severe	4,021,944
Moderate	8,372,925
Light	16,580,466
Scattered Light	25,809,902
	54,785,237

The acres listed in the table represent the total number of acres within each damage level. Non-forested acres were included.

Acreage Summaries	***In acres***
Damage Levels	***total lands affected***
Severe	4,620,880
Moderate	8,918,493
Light	19,008,357
Scattered Light	28,293,076
Total lands affected	***60,840,806***

Damage Summaries by National Forest

Acreage Summaries - NF's in MS

Acreage Summaries – NF's in AL

NF's in MS lands affected	2,054,761		NF's in AL lands affected	850,235
Damage Levels	***Bienville NF***		***Damage Levels***	***Bankhead NF***
Severe	-		Severe	-
Moderate	102,833		Moderate	-
Light	285,620		Light	-
Scattered Light	-		Scattered Light	349,392
Total Bienville NF affected	***388,453***		***Total Bankhead NF affected***	***349,392***

Damage Levels	***Delta NF***		***Damage Levels***	***Conecuh NF***
Severe	-		Severe	-
Moderate	-		Moderate	-
Light	-		Light	-
Scattered Light	34,921		Scattered Light	171,226
Total Delta NF affected	***34,921***		***Total Conecuh NF affected***	***171,226***

Damage Levels	***DeSoto NF***		***Damage Levels***	***Talladega NF***
Severe	456,870		Severe	-
Moderate	376,938		Moderate	-
Light	-		Light	-
Scattered Light	-		Scattered Light	329,617
Total DeSoto NF affected	***833,808***		***Total Talladega NF affected***	***329,617***

Damage Levels	***Holly Springs NF***
Severe	-
Moderate	-
Light	-
Scattered Light	300,637
Total Holly Springs NF affected	***300,637***

The acres listed in the table represent the total number of acres within each damage level. Non-forested acres were included.

Damage Levels	***Homochitto NF***
Severe	-
Moderate	-
Light	5,926
Scattered Light	371,365
Total Homochitto NF affected	***377,291***

Damage Levels	***Tombigbee NF***
Severe	-
Moderate	-
Light	-
Scattered Light	119,651
Total Tombigbee NF affected	***119,651***

Fire behavior implications:

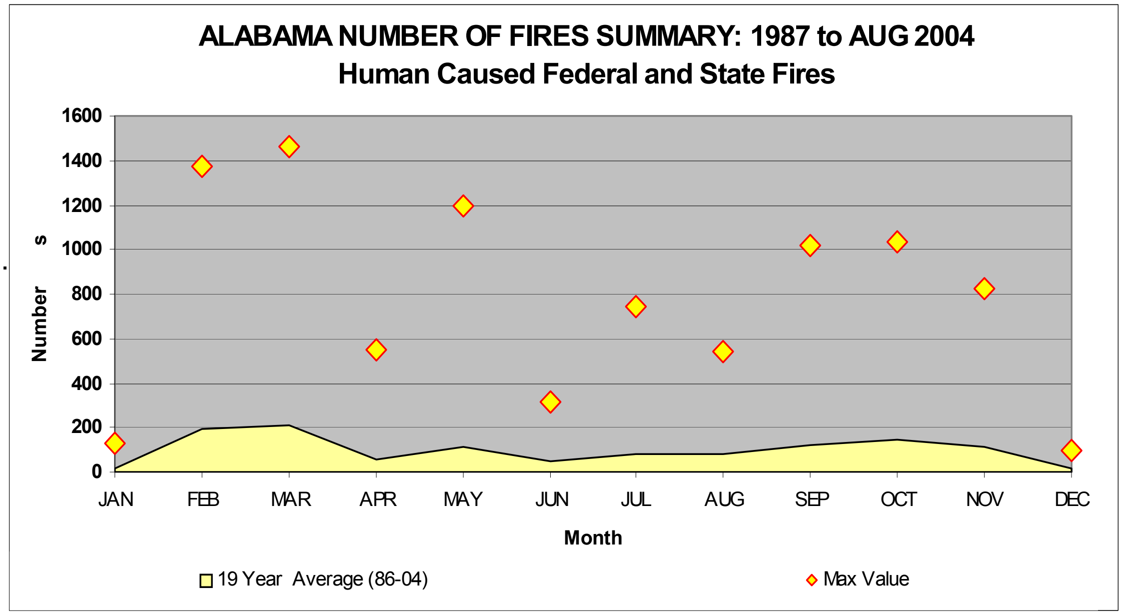
Historical weather analysis was done using Fire Family Plus utilize existing fire weather stations in Florida. Moderate weather and fuel conditions were determined to illustrate the difference in fire behavior potential by fuel type. This data was then input into Behave Plus to determine pre-storm burning conditions by fuel type.

The analyses determined that rate of fire spread will not change significantly however the added fuel loading will increase the flame length and intensity. The increase in flame lengths and fire line intensity will significantly change fire fighting tactics. Historically, flame lengths were within the limits for direct attack or a combination attack with small dozers (450's). In the moderate to severe damage areas, fire line intensities under "normal" fuel moisture conditions will be too high for direct attack. This is due to the large amount of dead and down material available to burn. A combination and/or indirect attack will most likely be needed in the moderate to severely damages areas. Fires will generally become more fuel driven. This will increase the likelihood of extreme fire behavior under moderate fuel moisture conditions. Also, spotting will become more likely due to the amount of dead fuels on the ground. The increase in heavy dead fuels, down pines, and salt killed brush has created more source for spotting brands. The increase in fine fuels across the area will the receptive nature of the fuel bed. The larger diameter fuels will cause fires to burn more actively into the night.

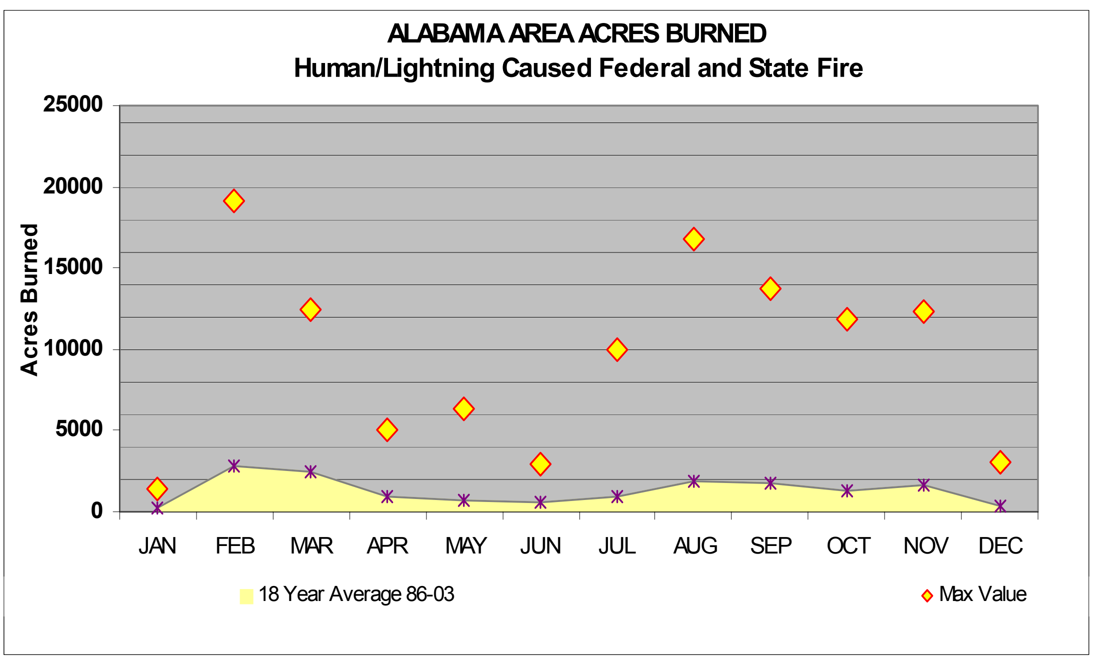
Mop-up will be more difficult and the chances for holdover will increase. Longer commitment times for fire crews will be needed and this will decrease the capabilities of initial attack resources. Smoke production will also increase presenting additional challenges for aerial operations as well as health concerns down wind. Effect on remaining overstory will be more severe with increased scorch, torching and mortality.

Fire Occurrence

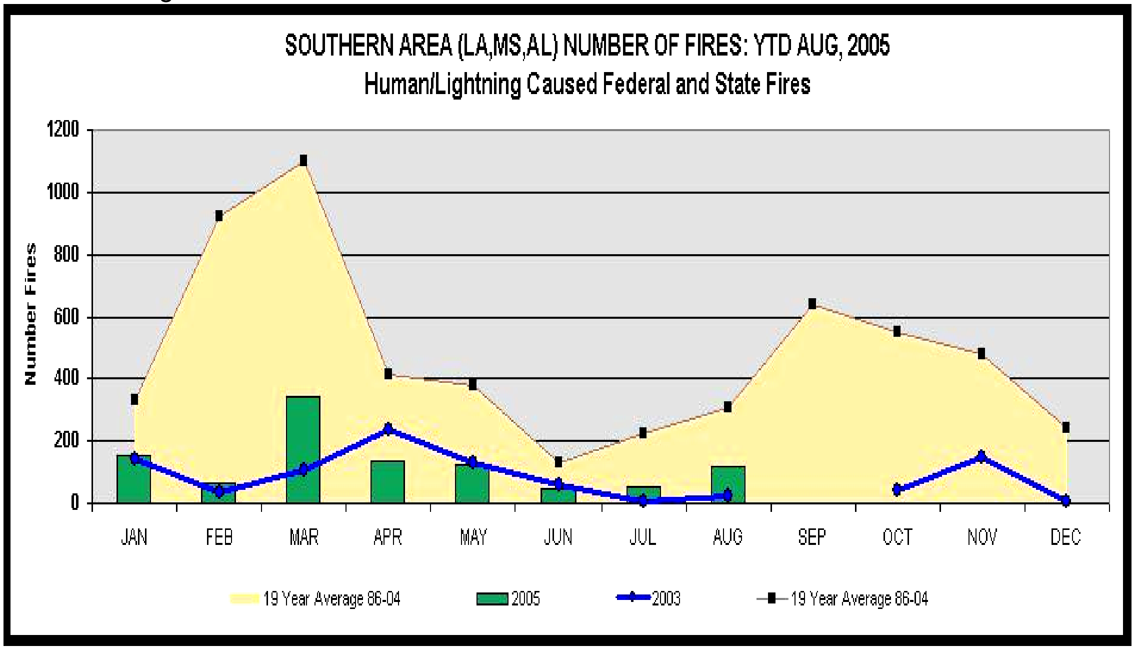
Fires occur year round in the hurricane affected area. For the purposes of this assessment, fire season was determined at the time(s) of the year that fires are likely to occur and do significant damage. The critical time of the year for fire occurrence is September 1 to May 31. It is important to note the largest cause of fires in this area, regardless of landownership, is human caused. The USFS owned land has arson as the large cause of fires. Fires on all other land is relatively evenly broken out by 50% debris burning and 50% arson.



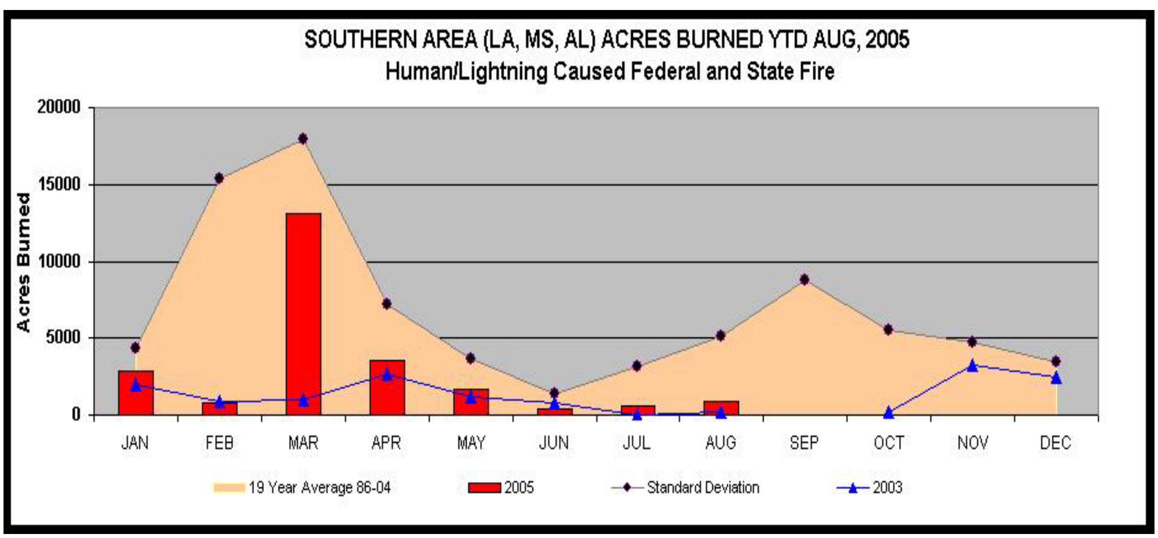
These two charts are the acres burned and number of fires for both state and federal land in Alabama. Both charts indicate a bimodal fire season. This is shown by the number of fires and acres burned increasing in January to March. Fire activity decreases during the summer months due to rain and green up of vegetation. Fire activity then increases in the late summer months and early Fall due to late summer drought. It is important to remember that many of the fires in Alabama during the late summer months tend to be located outside of the damage area of the hurricane. The area with the biggest fire activity during this time is central and northern parts of the state.



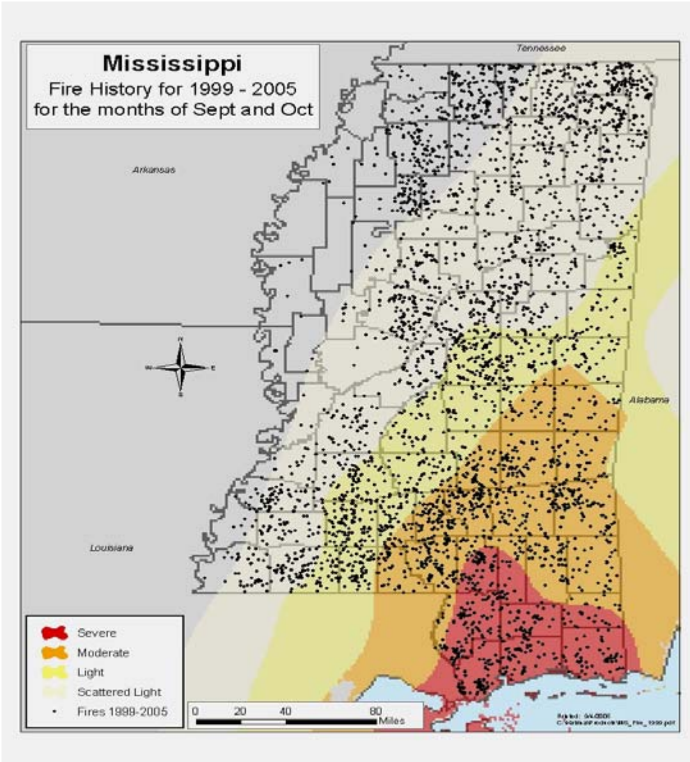
The chart below illustrates the number of fires with in the states of Louisiana, Mississippi, and Alabama regardless of landownership. Historically, September, October, and November are one of the peaks of the fire season. The other peak of the fire season begins in January and climbs until the end of March. It is important to note one of the peaks of the fire season is occurring right now. Also, since one of the largest causes of fires historically is debris burning, one can expect a larger number of fires occurring due to the large number of debris burning likely to occur due to the large amount of debris from the hurricane.



The acres burned show a similar pattern as the number of fires. There are two distinct peaks in the season. One peak in September, with a slight decline into December and another peak in March.

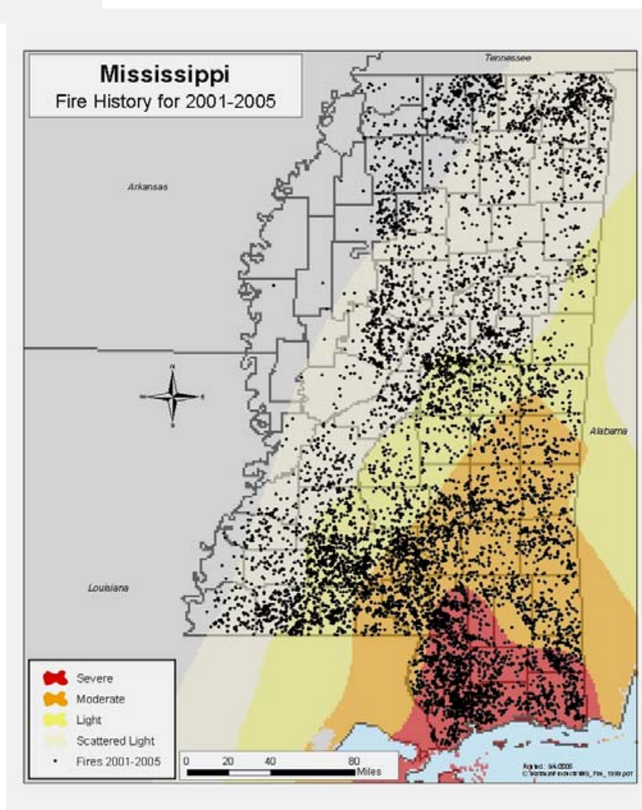


The data on fire activity for LA, MS, and AL bring to light the following important information. Human caused fires, particularly debris burning will likely be a large cause of fires in the very near future. This would indicate the importance of fire education and prevention efforts in the next couple of months along with increasing fire preparedness. Also, due to the large number of acres burned in late spring and early summer, preparedness, prevention and hazard fuel treatments will all become important prior to this time period



The image to the left depicts the number of fires for the state of Mississippii from1999 to 2005 which occurred in the months of September and October. Damage levels are overlayed on the map. One can tell there is a significant amount of fires which historically occuring in the moderate to severe damage area.

The map to the right illustrates number of fires for the state of Mississippi for all months which occurred from 2001 to 2005. One can see the large amount of fires which occur in the light, moderate and severe damage areas. This is a significant indication fire prevention, fire preparedness, and fuel reduction activities will need to increase to effectively deal with the increased risk from fuel accumolation.

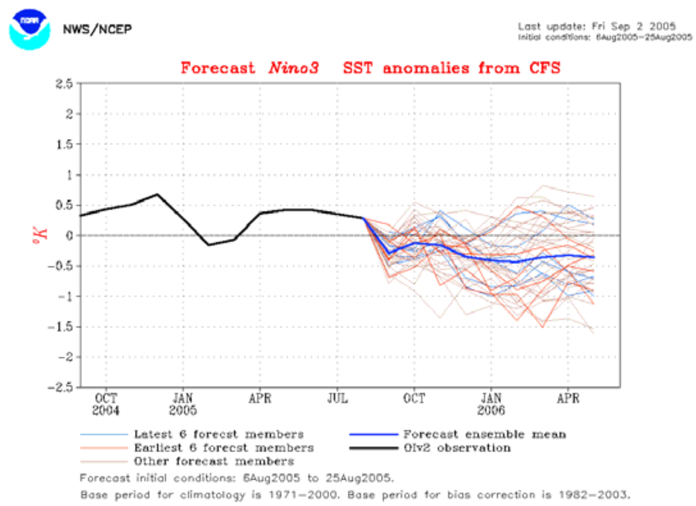


Wildland Urban Interface

The area affected by the hurricane contain a vast amount of interface areas. Refer to the map of WUI areas in the Appendix. This will provide a great challenge to wildland fire managers. Fire acitivity is normally higher in these areas due to debris burning. Fuel reduction and preparedness activities will need to be greatly enhance to protect the communities at risk. Communities should develop a community protection plan to determine short and long term strategies.

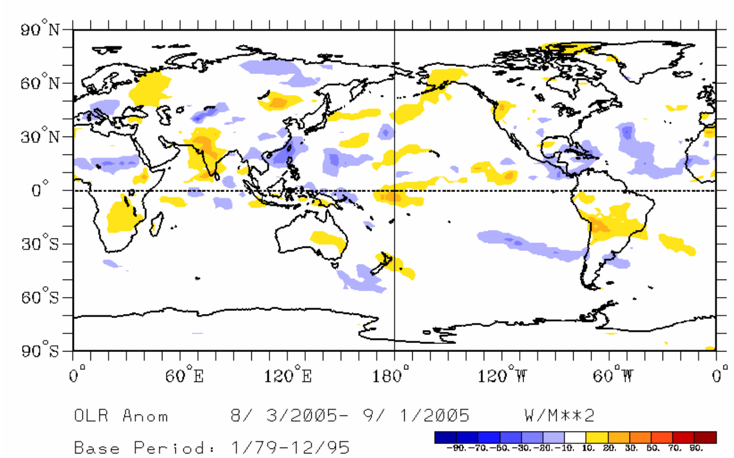
Climate Forecast Summary

At this time the forecasted ENSO for the remainder of 2005 and into 2006 would indicate that a weak cool event will persist during the period. However, the signal is rather weak and conditions are likely to remain in the neutral range from -0.5 C to +0.5 C. Strong La Nina events are often associated with warm dry autumns in the southeastern US. The Anomaly of Outgoing Long Wave Radiation (the second image to the right) remains rather neutral, indicating no significant departure from normal of the average pattern of deep convection (and thus precipitation) over the central Pacific. As the OLR becomes negative, the Pacific begins to produce more convection.

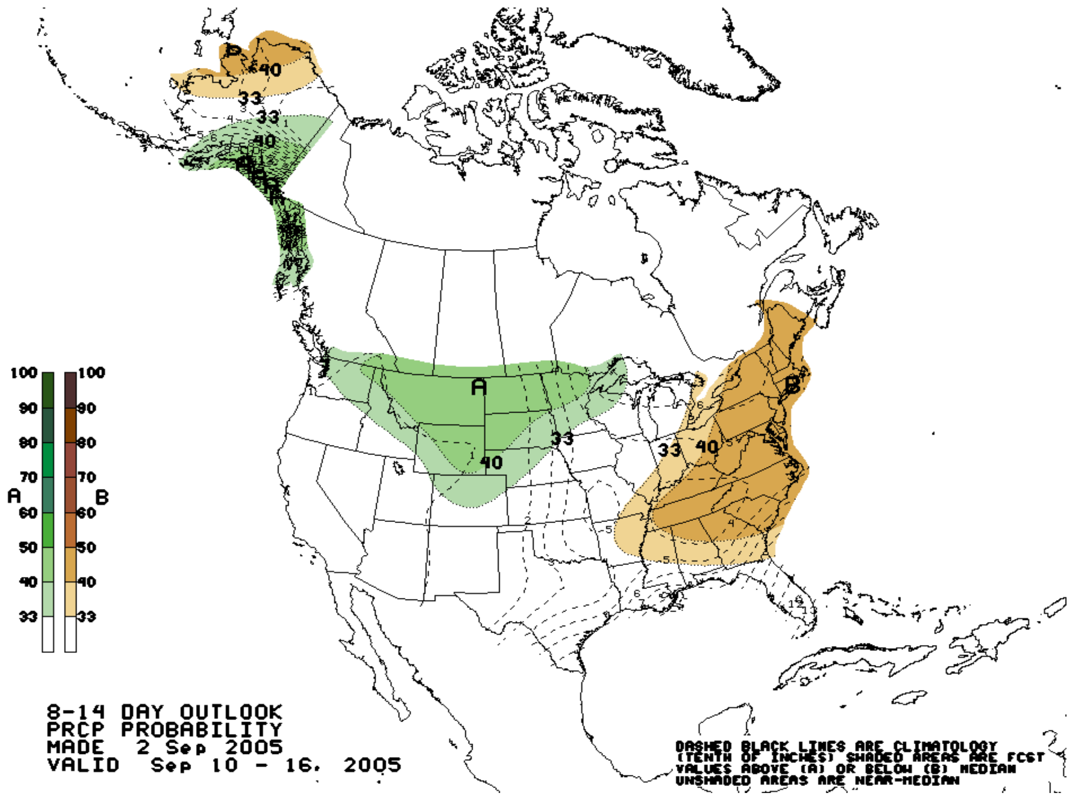


The Southern Coastal Plain's teleconnection with the ENSO has been well documented. A positive index (warm event) should produce a reduced fire season because of the increased amounts of precipitation.

At this time, the Climate Prediction Center is uncertain as to how long this slightly cool episode will last.



The short term forecast (next 14 days) may give a little more indication for fire potential. After the hurricane passage, a high pressure system has set up providing a north/northeast flow over the impacted area. This is providing for a relatively dry air mass, low relative humidity, and a very low probability of significant rainfall. The 8 – 14 day outlook from the Climate Prediction Center provides an example of the impact of this weather pattern. Southern MS is not showing below normal changes for rain, because September and October are historically the lowest rainfall months.



It is

Also important to note the average "days since rain" for this area is about 20 days. Based on the mid term forecast, it is likely the area will at least reach this mark by the middle of September. Since September and October the months with the lowest rainfall, it is likely that the drying trend will continue.

Management Implications

The damage produced by Hurricane Katrina has significant implications to fire management professionals. There are several management actions which apply across the board to all levels. The impact of Hurricane Katrina will be in place for a long period of time. The Mississippi Forestry Commission, to this day, does not have access to some of the damage areas caused by Camille in 1979. Therefore, some base fire management day to day decision points may need to be re-evaluated due to the increase in fire potential. The National Fire Danger Rating System (NFDRS) is a trusted tool used by fire managers across the country and useful for determining staffing levels, dispatch levels, fire restrictions, adjective fire danger rating, and seasonal severity. Trigger points for these fire management decisions will need to be re-adjusted for changes in fuel type and to reflect new fire potential. Fire behavior will increase faster on lower "fire danger" days and will need to be staffed accordingly. Dispatch levels will need to reflect a higher fire potential. Therefore, more resources and different types of resources will need to be sent on lower risk days. Many land management agencies do not have breakpoints for these fire management decisions. A Fire Danger Operating Plan should be developed to adequately prepare for fire activity during the fire season.

The scattered light damage level will require very minimal, if any changes to current fire management activities. This area received the least amount of damage. The light damage level will require some additional preparedness activities. A slight increase in the number of initial attack resources on fires may be needed. Generally, no change in hazardous fuels activities. Regularly scheduled prescribe burns should reduce the increase in fuel accumulation.

The moderate damage level areas will require several changes to normal management activities. Due to increased fire potential in this area, fire prevention teams will be needed. Prevention work should focus on proper debris burning techniques, possible implementation of burning bans, and aggressive arson investigations. Preparedness activities will need to be greatly enhanced. Larger dozers and engines will be needed to deal with the increased fuel build up. Aerial resources will be needed to cool the fire and allow ground crews to get close. Aggressive detection will be needed to keep fires small. Hazardous fuels work will likely require mechanical treatments before prescribe fire can be utilized.

The severe damage area will require the most extensive change in management. Prevention teams will also need to be utilized in this area. Aggressive detection will also be needed. Larger dozers and engines will be needed in this area as well as aviation assets. Hazardous fuel reduction activities will require mechanical work before prescribe fire can be utilized.

Management Recommendations

Prevention: The previous hurricane and blowdown situations all implemented aggressive prevention programs. This is an important component of a wildfire mitigation plan. FIREWISE is an excellent tool that can be implemented quickly by prevention teams.

Debris burning is a leading cause of fires in the southeastern area. Escaped debris burning has already resulted in two escape fires in Harrison county in MS. The highest period of incidence for these types of fires occur in September, October, January, February and March. Prevention messages or limitations on these types of permits in areas of severe to moderately damaged areas are a high priority.

Fire restrictions may need to be re-evaluated. New restrictions may be temporarily put in place until fuel reduction goals are met. Also, the trigger points and criteria at which restrictions are put in place may need to be altered.

Land management agencies may need to take aggressive steps to reduce escape debris burning fires: such as designating gravel pits for debris disposal and burning that material. Fire prevention teams should take aggressive steps to educate the public on proper debris burning techniques.

Prevention teams can be used to provide overall coordination and provide expertise to local fire protection agencies.

Detection: Early detection is a critical step in keeping fires small and reducing loss of life, property and keeping suppression costs low. Criteria on when and where detection is utilized will need to be re-evaluated.

Preparedness: Upgrading to larger dozers will be necessary to work in areas where fuel treatments or salvage can not be accomplished. The smaller dozers and tractor plows generally in use will not be effective in the areas of heavier blowdown. This heavier equipment will be needed for up to three years before the loading drops and the boles soften to the point that the smaller dozers and tractor plows can be used. The smaller equipment will still be effective in areas not impacted by heavy blowdown. This equipment will be needed in the moderate to severe damage areas.

With the loss of a majority of the large airtankers to the federal fleet the need to supplement these resources will be critical. Helicopters and SEATs can be effective on fires when they are small. To be effectively utilized they must be activated early. States independently have the ability to contract additional larger airtankers that are not under federal contract. There would be limitations on their use on federal lands however. The time of the year when the largest number of fires and acres burned occur is outside the normal western fire season. Every effort should be made to provide at least one contracted heavy airtanker to the area effected.

Salvage Logging and utilization (as a form of fuel; treatment): Historically based on at least two of the case studies salvage logging has been only marginally effective. Still it remains a tool that can not be over looked. It will be important to accelerate the planning timeline to best recovery the economic value.

Fuel treatments: There is a full range of options available and each has its time and place. These range from prescribed burning, piling wind rowing, chipping, crushing and mulching depending on situation. These treatments might be used in protecting communities or single structures. They might be used to break up large area of continuous fuels by constructing fuel breaks. Or they might be used in a patchwork pattern based on Finny's models to reduce fire spread rates and intensity. The areas for treatment will need to be prioritized as time and money will be a limiting factor. This prioritization process is best left to the local states and forests to accomplish based on current community protection plans.

Training and equipment for state and local fire protection agencies will be needed and is recommended. Simply put some to of the equipment currently is service will not be up to challenge in the short run for dealing with the resistance to control that is now present. Training of local fire fighters will be necessary for them to understand the implications of fire behavior in these heavily modified fuels. Modifications in strategy and tactics will be required in order to increase the success of attack and increase the margins for safety. Volunteer Fire Departments respond to the vast majority of fires in this area. Increasing the capabilities of these departments should be critical. This should come in the form of increased training, equipment and personal protective equipment.

Planning for community protection: Significant changes have taken place in and around communities. Many plans will need to be changed to reflect the changing fuels conditions. Those who have not yet completed plans should do so given the current conditions. Money is indicated to allow for the planning and for implementation of some critical projects.

Locally disposal sites can be developed where small land owners and individuals can bring debris for burning or other chipping. This may reduce the potential for land owners wanting to burn by giving them a safer alternative. These locations can be advertised as part of the prevention messages.

Issues needing consideration

Fire weather forecasts indicate there this continued potential for additional storms to impact the United States. Should this happen modifications to the plan would be in order.

Salvage is expected to significantly reduce fuel reduction costs, particularly on National Forest land. If this turns out not to be the case, further evaluation of fuel reduction priorities will be needed.

Smoke production and management will become more of an issue for prescribed fires and wildfires for the next decade or so. A stepped up campaign to inform the public will be needed.

The number of acres identified as needing treatment and the costs of those treatments are extraordinary. The team anticipates that the money will be a limiting factor in implementation. Should funding become available the sheer magnitude of the job will be difficult to accomplish. As a result additional local assessments will be needed in order to prioritize the acres for treatment, identify specific cost effective treatments and facilitate implementation. It is beyond the capability of this team to undertake this task due to the number of unknowns present.

Conclusions

- Hurricane Katrina had a dramatic affect on fuel loading increase that will have profound effects on fire behavior for many years. Areas hardest hit have seen as much as a 20 fold increase in down and dead fuels.
- The states are not currently prepared to take on the additional work that this change in fuels and resulting fire behavior will generate.
- Additional initial attack support to the states and local fire departments will be needed in order to reduce the potential for large destructive fire.
- Fuels treatment by various methods will need to be implemented as soon as possible to begin mitigation before the beginning fire season.
- Prevention activities have proven effective in reducing human caused fire and needs to be aggressively implemented.
- Additional detailed state and local assessments will be required to develop site specific recommendations and set priorities.

Acknowledgements

The team would like to thank Bill Lambert (Mississippi Forestry Commission), Kirk Casanova (Louisiana Office of Forestry), and Richard Cumbie (Alabama Forestry Commission) for providing valuable information on conditions across their respective states and input. Jon Wallace (Mississippi Forestry Commission) for input into the extensive damage along the coast, impact on fuel conditions and pictures. Kevin Scasny and Denver Ingram (Southern Area Coordination Center) for providing some graphics and input into future weather conditions. Dennis Jacobs (Southern Research Station) for providing the initial damage assessment map.

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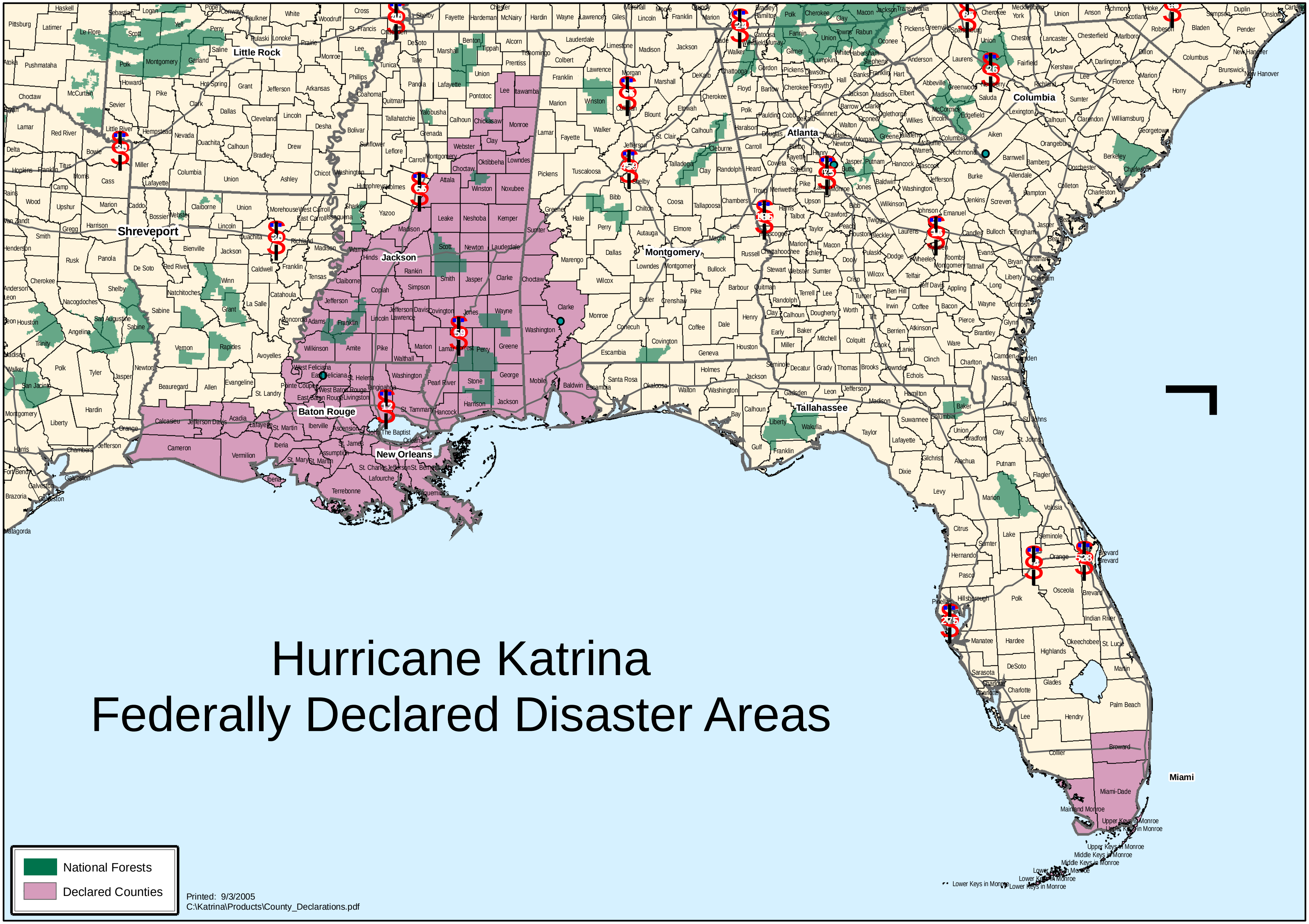
Appendix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Atlanta
Columbia
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New Orleans
Tallahassee
Miami
National Forests
Declared Counties
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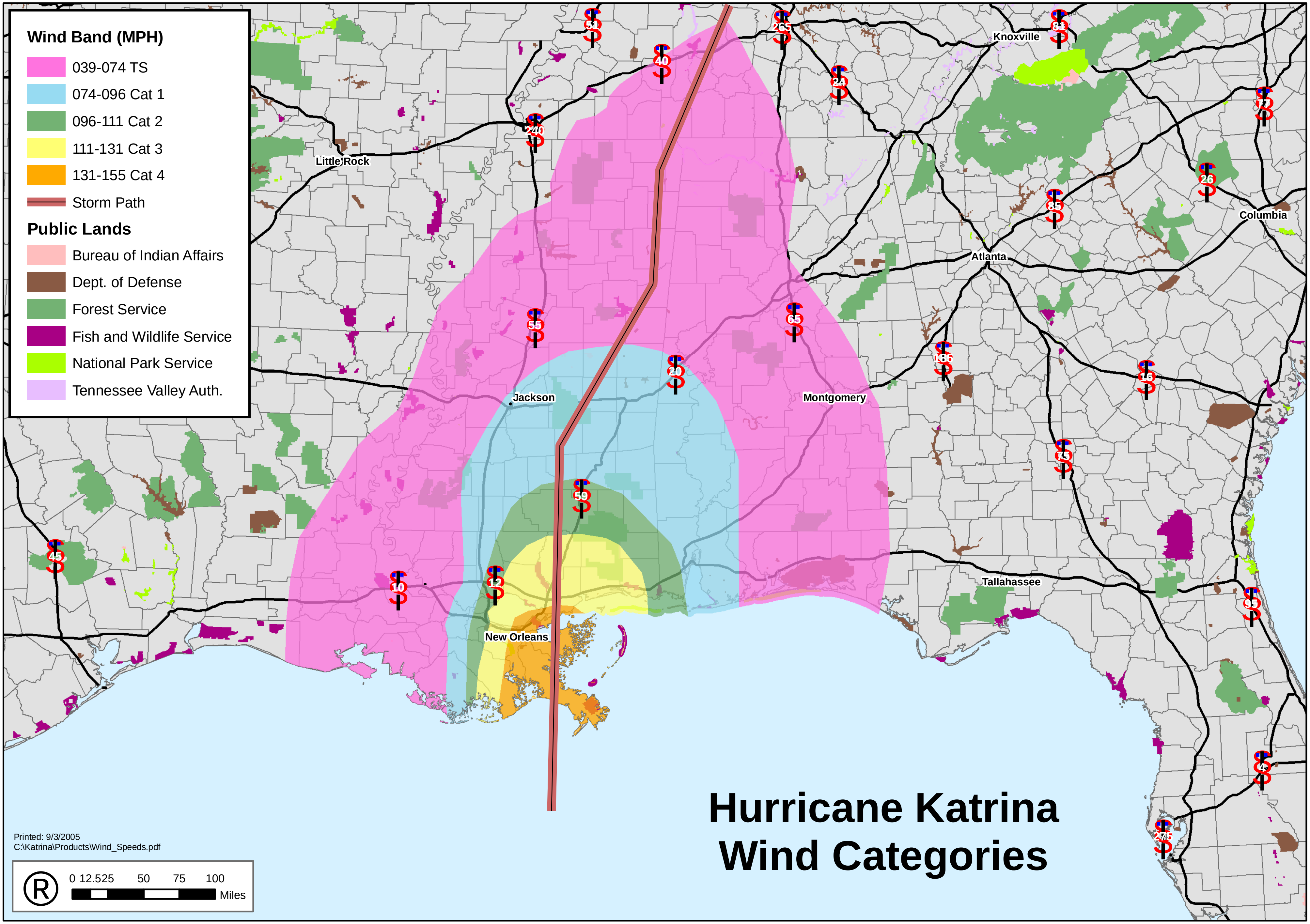
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074-096 Cat 1
096-111 Cat 2
111-131 Cat 3
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Bureau of Indian Affairs
Dept. of Defense
Forest Service
Fish and Wildlife Service
National Park Service
Tennessee Valley Auth.
Little Rock
Knoxville
Columbia
Atlanta
Jackson
Montgomery
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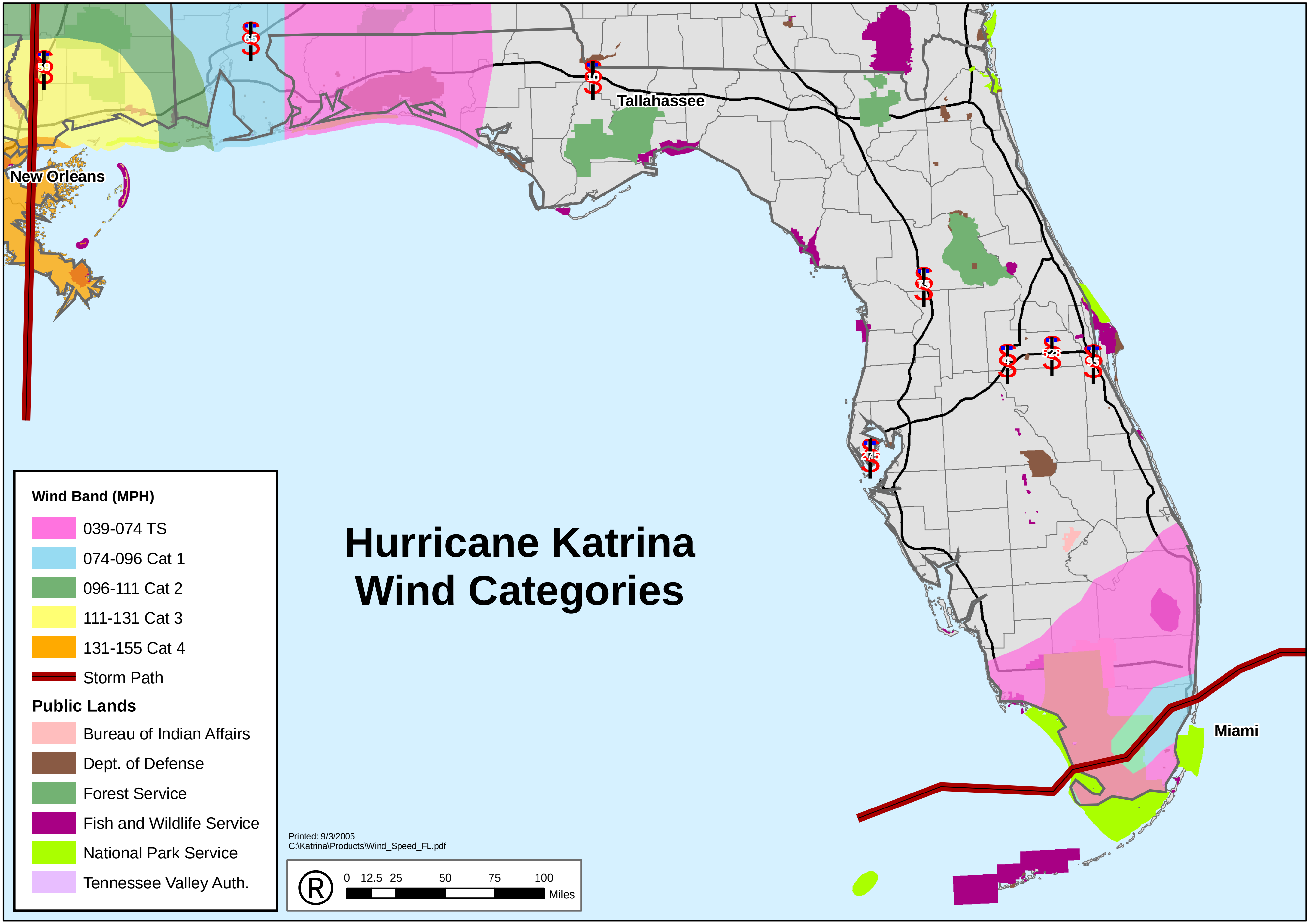
Wind Categories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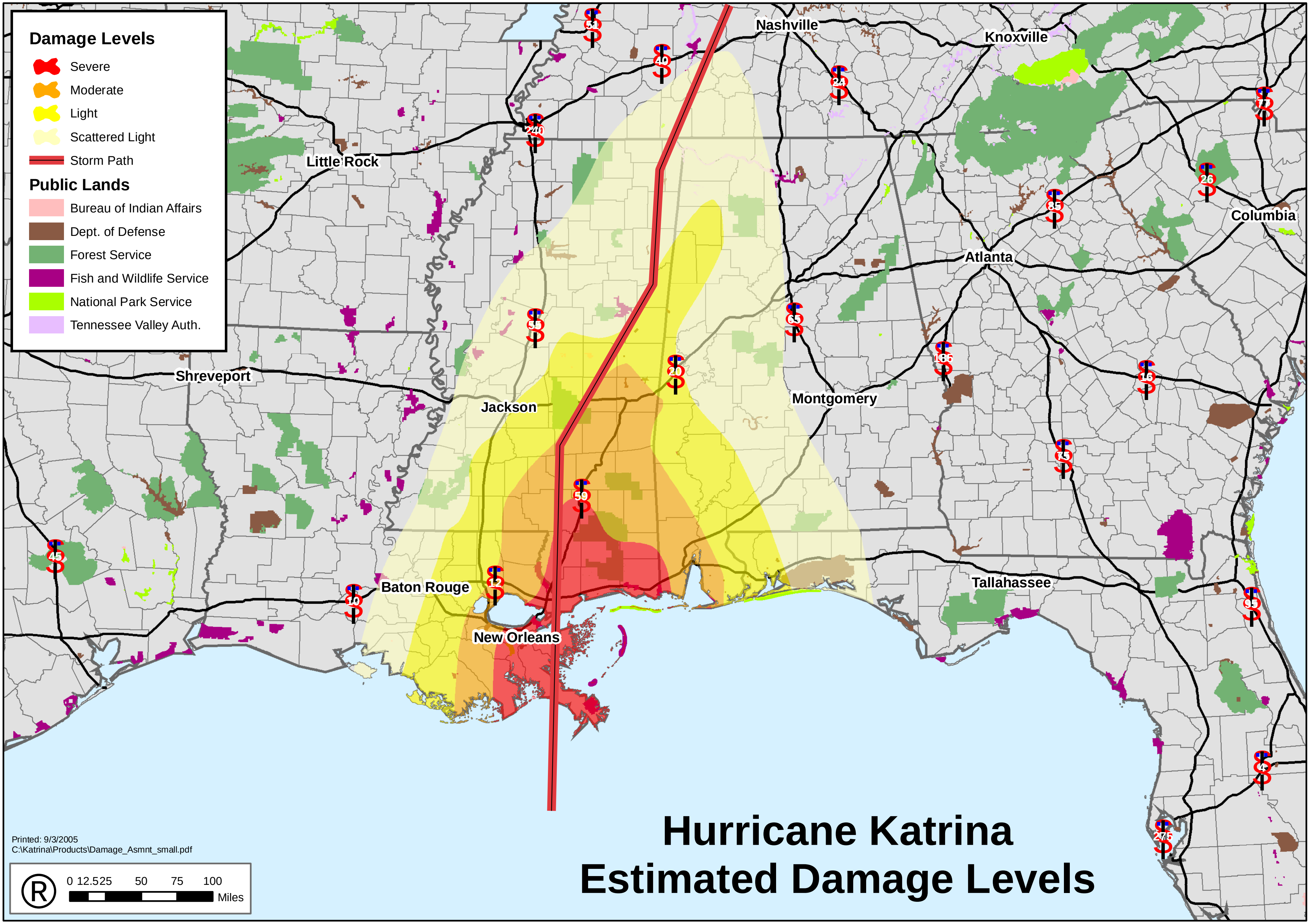
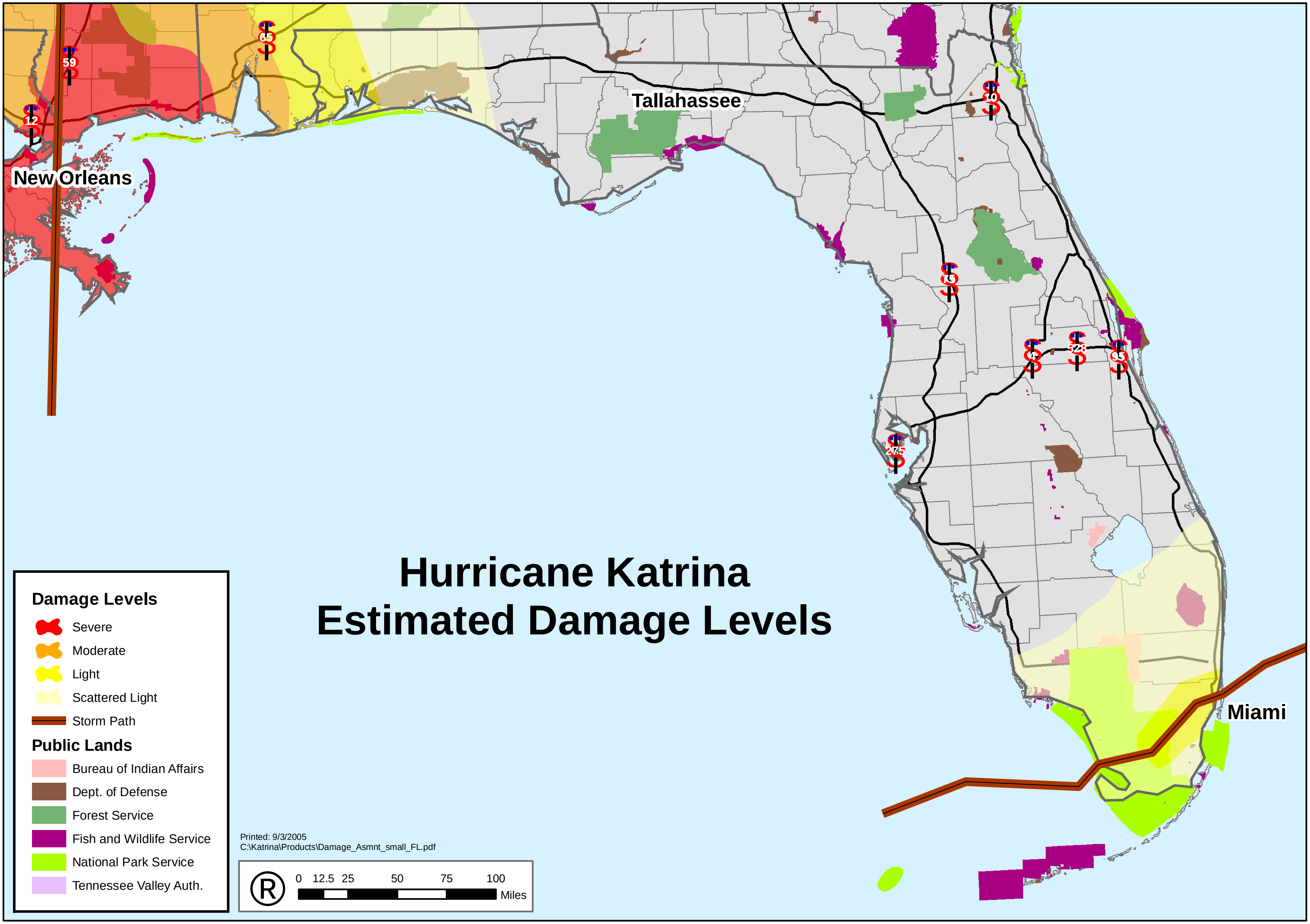
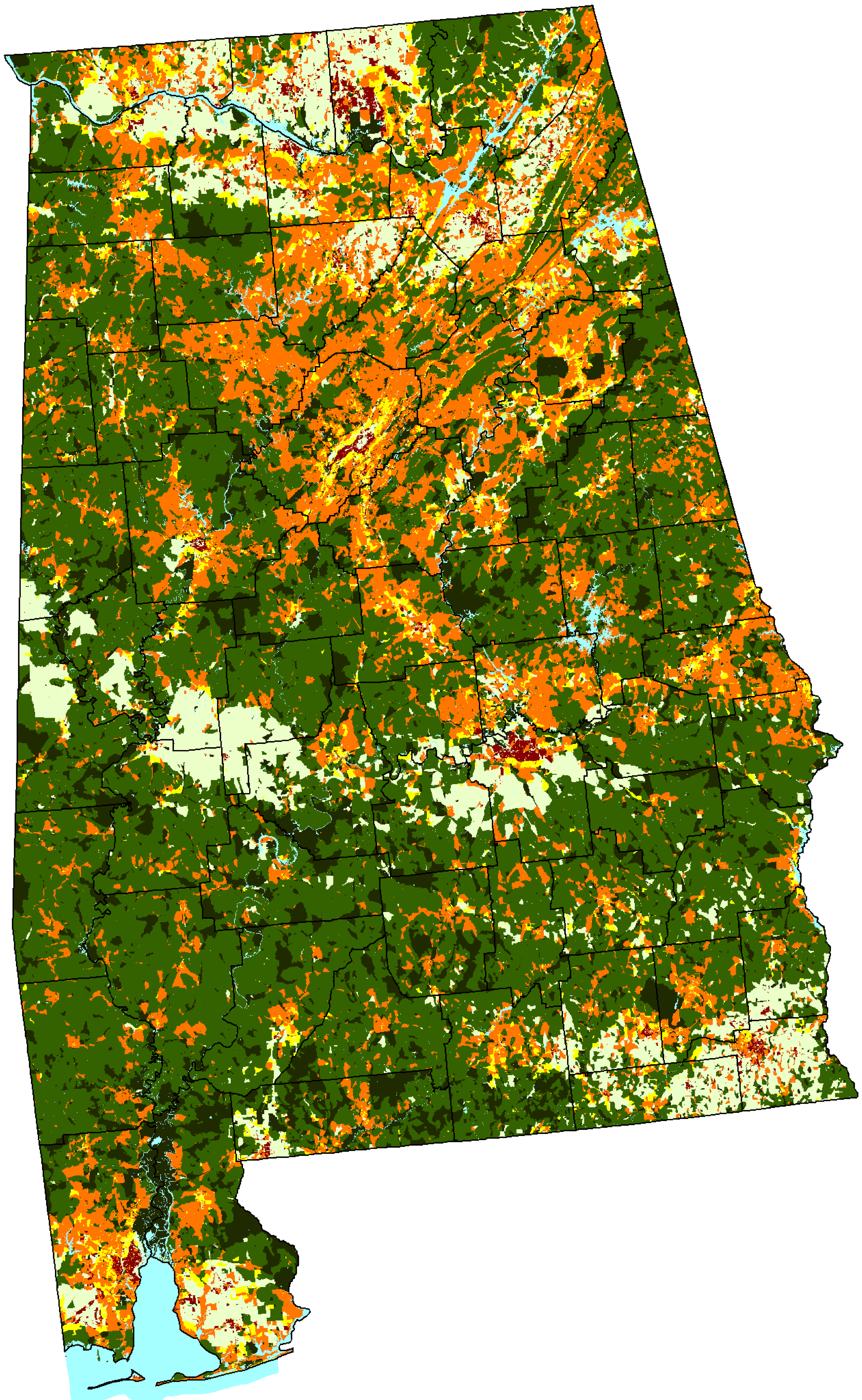
Tennessee Valley Auth.
Printed: 9/3/2005
C:\Katrina\Products\Wind_Speed_FL.pdf
0 12.5 25 50 75 100
Miles


Damage Levels
Severe
Moderate
Light
Scattered Light
Storm Path
Public Lands
Bureau of Indian Affairs
Dept. of Defense
Forest Service
Fish and Wildlife Service
National Park Service
Tennessee Valley Auth.
Nashville
Knoxville
Little Rock
Columbia
Atlanta
Shreveport
Jackson
Montgomery
Tallahassee
Baton Rouge
New Orleans
Printed: 9/3/2005
C:\Katrina\Products\Damage_Asmnt_small.pdf
0 12.525 50 75 100
Miles
Hurricane Katrina
Estimated Damage Levels


Hurricane Katrina
Estimated Damage Levels
New Orleans
Tallahassee
Miami
59
12
65
Damage Levels
Severe
Moderate
Light
Scattered Light
Storm Path
Public Lands
Bureau of Indian Affairs
Dept. of Defense
Forest Service
Fish and Wildlife Service
National Park Service
Tennessee Valley Auth.
Printed: 9/3/2005
C:\Katrina\Products\Damage_Asmnt_small_FL.pdf
0 12.5 25 50 75 100
Miles

Alabama

Wildland Urban Interface 2000



WUI

- Intermix
- Interface

Non-WUI

Vegetated

- Very Low Density Housing
- No Housing

Non-Vegetated or Agriculture

- Medium and High Density Housing
- Low and Very Low Density Housing

- County Boundaries
- Water

Map Version: January 2004

Kilometers

0 20 40 80 120 160

0 10 20 40 60 80

Miles

Research funded by the USDA Forest Service

North Central Research Station
NC-4902 Natural Environments for Urban Populations
Evanston, IL 60201

Contact: John Dwyer
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Research conducted at the University of Wisconsin by APL and SILVIS

Applied Population Laboratory
Department of Rural Sociology
Madison WI 53706

Spatial Analysis for Conservation and Sustainability
Department of Forest Ecology and Management
Madison WI 53706

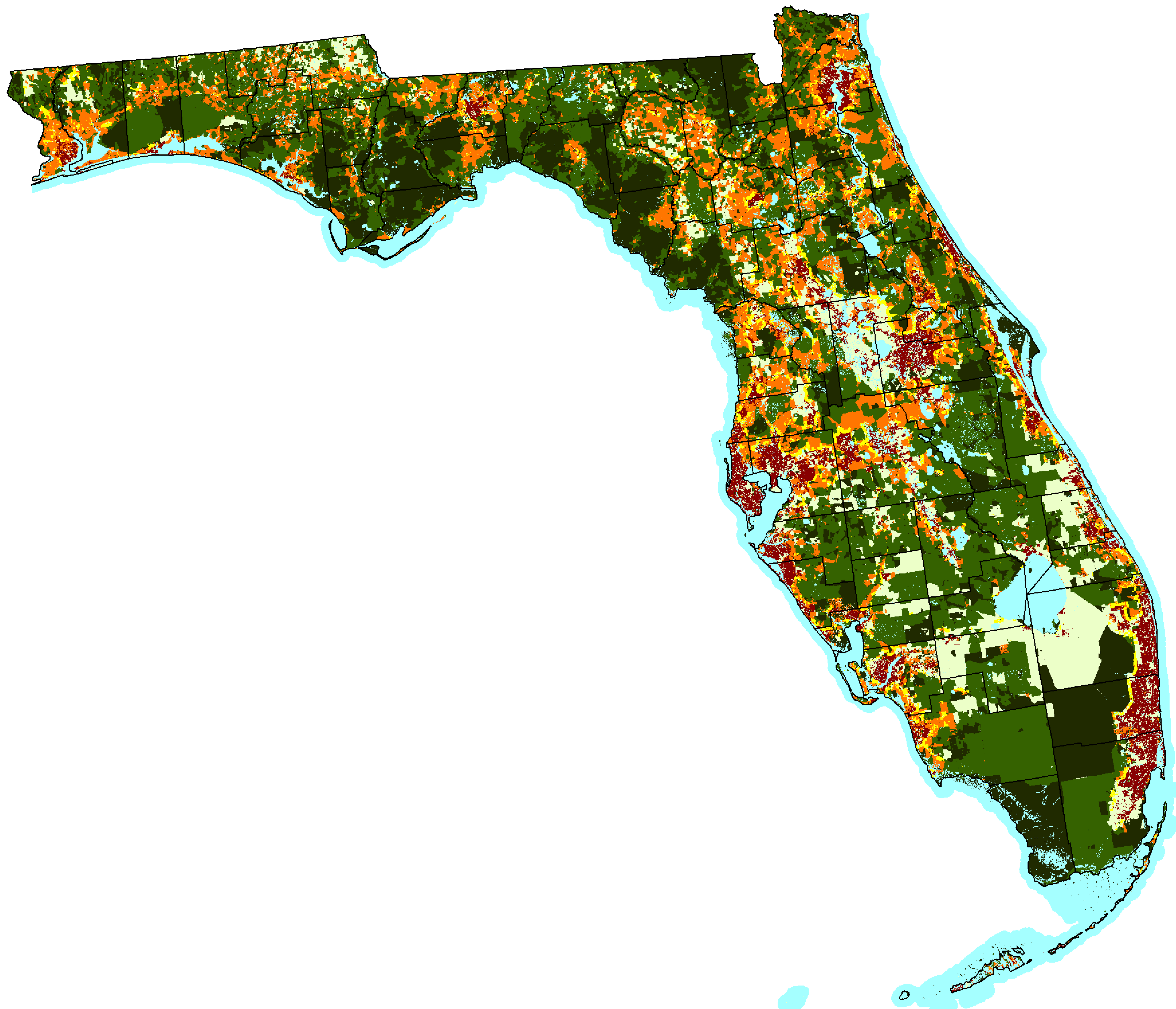
Contact: Roger Hammer
rhammer@facstaff.wisc.edu

Sherry Holcomb, Jason McKeefry
Contact: Volker Radeloff
radeloff@facstaff.wisc.edu

- Intermix WUI is >50% vegetated and has at least low housing density
- Interface WUI is not vegetated, has at least low housing density, and is within 2.414 km of an area that is >75% vegetated and >5 sq. km in size
- Housing density is measured in units per sq. km. Density classes are very low (<6.17), low (6.17-49.21), medium (49.21-741.31), and high (>741.31)
- Vegetation includes forest, shrub, grassland, transitional or wetland but not agriculture (NLCD 1992/1993).
- Mapping units are 2000 US census blocks (US Census Bureau)
- Definition is based on the Federal Register (USDI/USDA 2001, vol. 66: 751)

Florida

Wildland Urban Interface 2000



Map Version: January 2004

WUI

- Intermix
- Interface

Non-WUI

Vegetated

- Very Low Density Housing
- No Housing

Non-Vegetated or Agriculture

- Medium and High Density Housing
- Low and Very Low Density Housing

- County Boundaries
- Water

Kilometers
0 30 60 120 180 240
0 15 30 60 90 120
Miles

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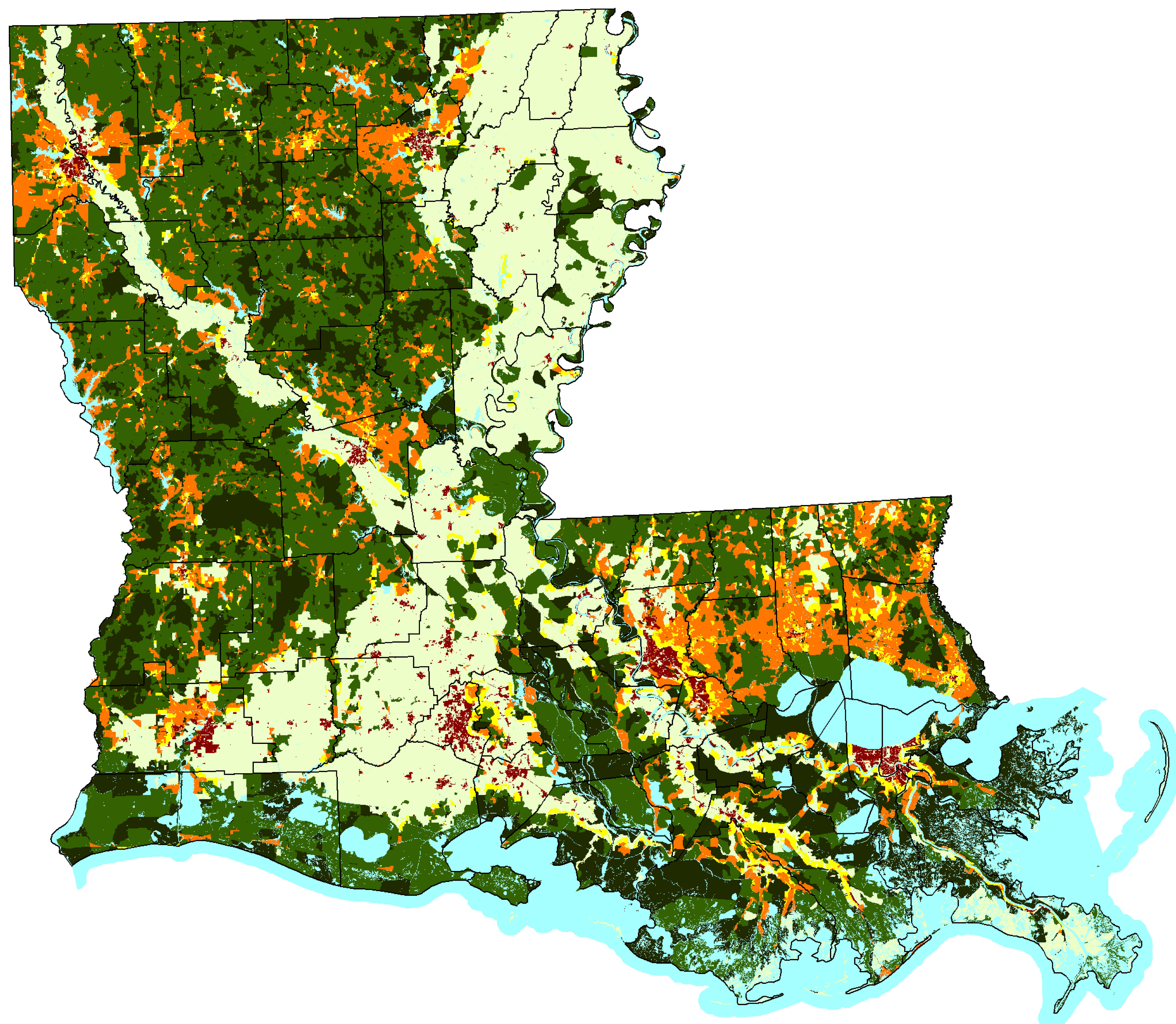
Louisiana
Wildland Urban Interface 2000



WUI

Intermix

Interface

Non-WUI

Vegetated

Very Low Density Housing

No Housing

Non-Vegetated or Agriculture

Medium and High Density Housing

Low and Very Low Density Housing

County Boundaries

Water

Map Version: January 2004

Kilometers

0 20 40 80 120 160

0 10 20 40 60 80

Miles

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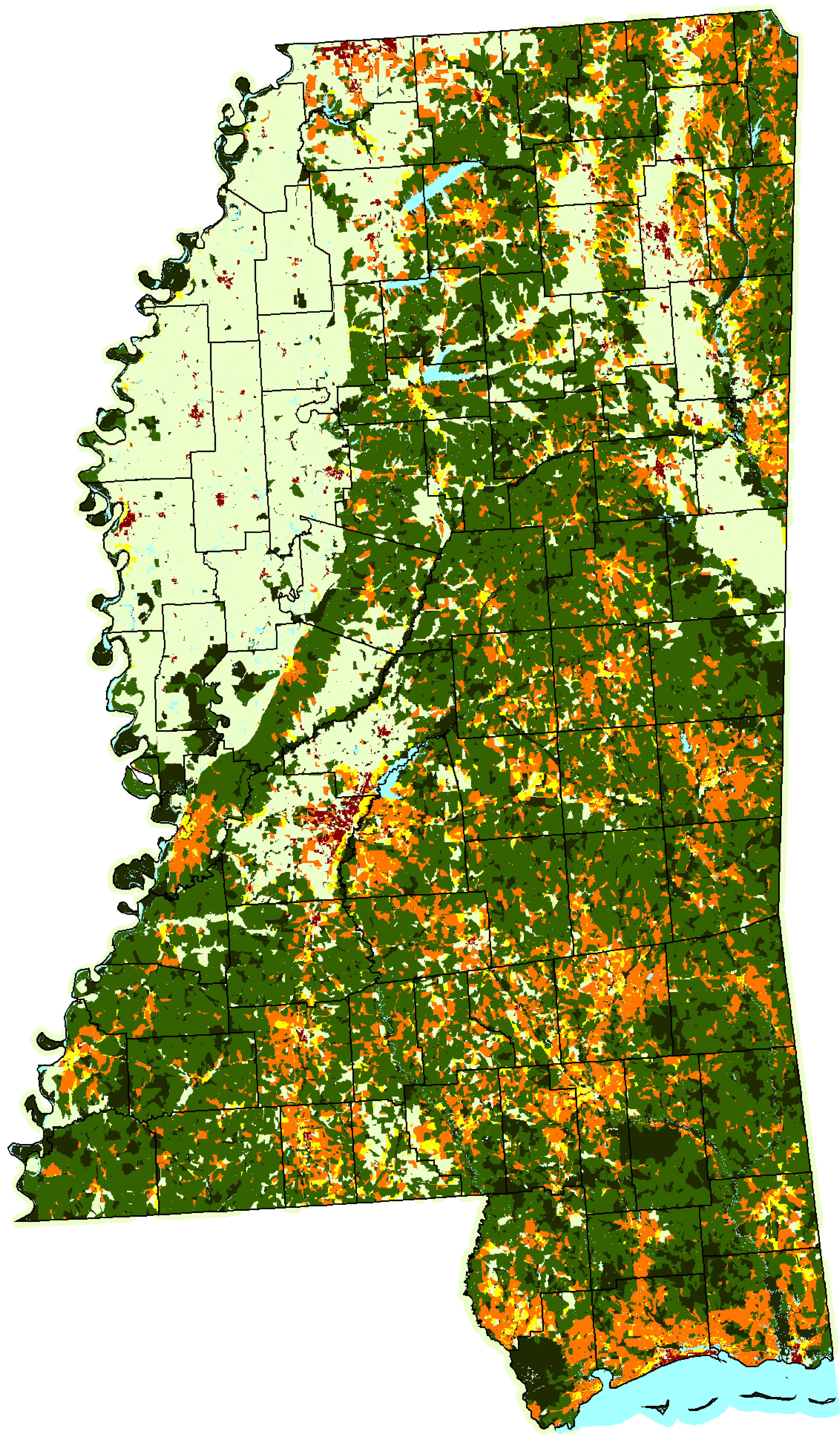
Mississippi

Wildland Urban Interface 2000



WUI

- Intermix
- Interface

Non-WUI

Vegetated

- Very Low Density Housing
- No Housing

Non-Vegetated or Agriculture

- Medium and HIgh Density Housing
- Low and Very Low Density Housing

- County Boundaries
- Water

Map Version: January 2004

Kilometers: 0 20 40 80 120 160

Miles: 0 10 20 40 60 80

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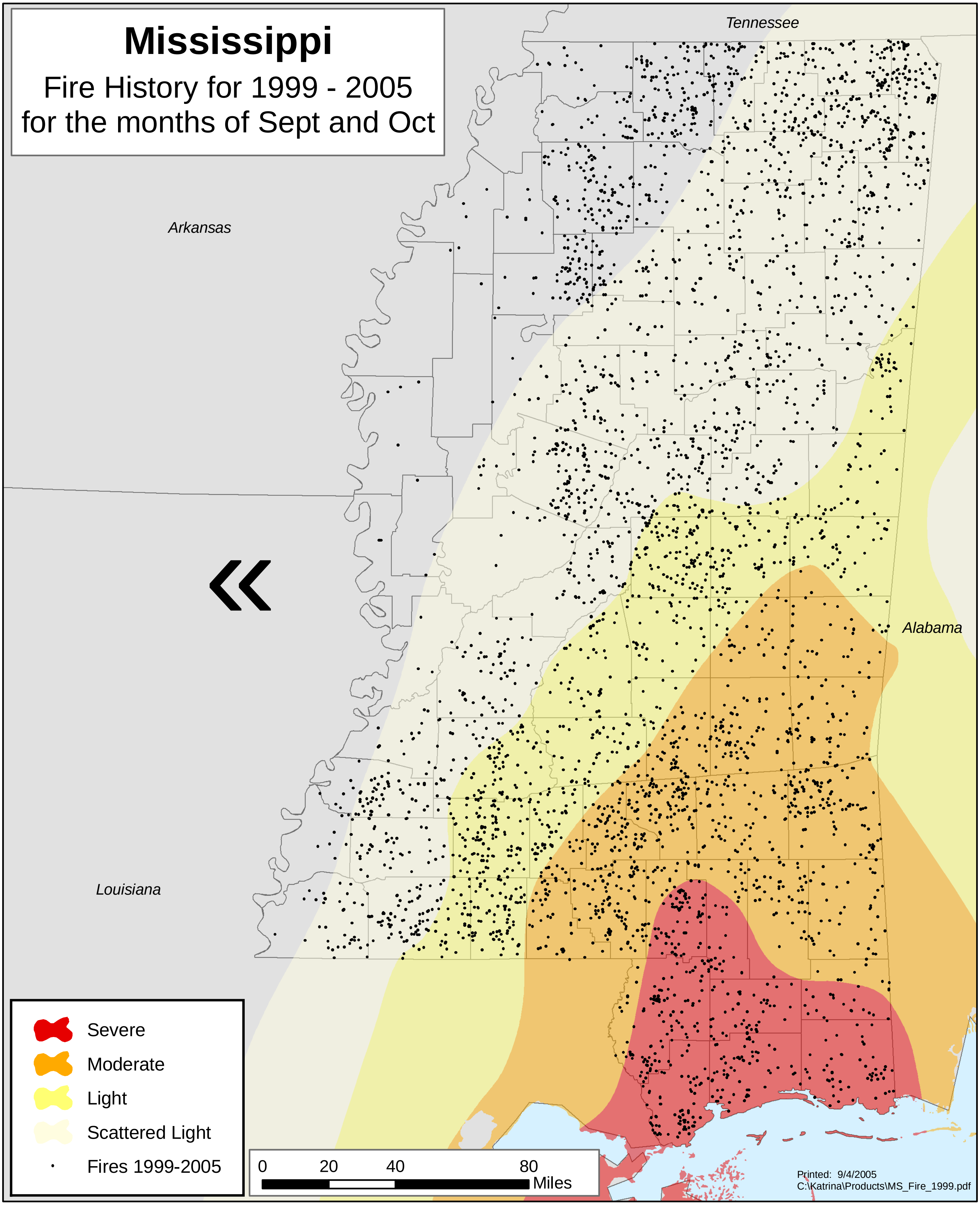
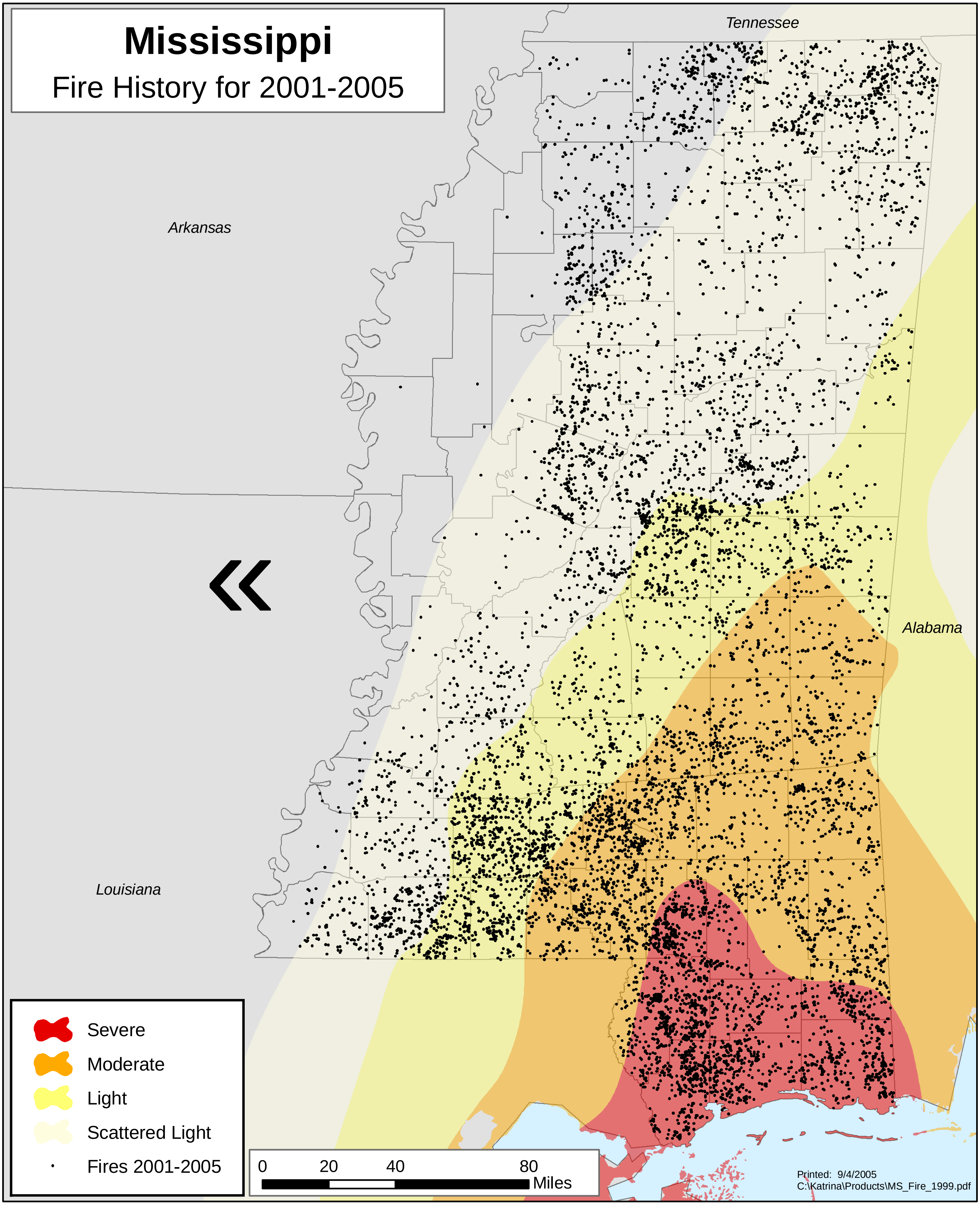


Mississippi
Fire History for 1999 - 2005
for the months of Sept and Oct
Tennessee
Arkansas
Alabama
Louisiana
Severe
Moderate
Light
Scattered Light
Fires 1999-2005
0
20
40
80
Miles
Printed: 9/4/2005
C:\Katrina\Products\MS_Fire_1999.pdf

Mississippi

Fire History for 2001-2005



Acreage Summaries		Estimated Cost Analysis	
Damage Levels	***total lands affected***	**Reduced by 20%**	**Acres needing treatment**
Severe	4,620,880	3,696,704	739,341
Moderate	8,918,493	7,134,794	713,479
Light	19,008,357	15,206,686	760,334
Scattered Light	28,293,076	22,634,461	
Total lands affected	***60,840,806***	***48,672,645***	***2,213,155***
Damage Levels	***BIA lands affected***		
Severe	-	-	-
Moderate	656	525	52
Light	169,943	135,954	6,798
Scattered Light	685	548	
Total BIA affected	***171,284***	***137,027***	***6,850***
Damage Levels	***DOD lands affected***		
Severe	7,242	5,794	1,159
Moderate	19,899	15,919	1,592
Light	54,415	43,532	2,177
Scattered Light	530,251	424,201	
Total DOD affected	***611,807***	***489,446***	***4,927***
Damage Levels	***FS lands affected***		
Severe	425,768	340,614	68,123
Moderate	480,136	384,109	38,411
Light	291,357	233,086	11,654
Scattered Light	1,682,056	1,345,645	
Total FS affected	***2,879,317***	***2,303,454***	***118,188***
Damage Levels	***FWS lands affected***		
Severe	137,902	110,322	22,064
Moderate	44,877	35,902	3,590
Light	199,048	159,238	7,962
Scattered Light	160,641	128,513	
Total FWS affected	***542,468***	***433,974***	***33,616***
Damage Levels	***NPS lands affected***		
Severe	28,024	22,419	4,484
Moderate	-	-	-
Light	1,712,096	1,369,677	68,484
Scattered Light	10,238	8,190	
Total NPS affected	***1,750,358***	***1,400,286***	***72,968***
Damage Levels	***TVA lands affected***		
Severe	-	-	-
Moderate	-	-	-
Light	1,032	826	41
Scattered Light	99,303	79,442	
Total TVA affected	***100,335***	***80,268***	***41***
Damage Levels	***State/Private affected***		
Severe	4,021,944	3,217,555	643,511
Moderate	8,372,925	6,698,340	669,834
Light	16,580,466	13,264,373	663,219
Scattered Light	25,809,902	20,647,922	
Total State/Private affected	***54,785,237***	***43,828,190***	***1,976,564***